Popular Science

MONTHLY Founded 1872

October
1929
25 cents

The Zeppelin Grows Up -

See Page 26

Fast-drying "Rogers" colors simplify home decoration for you

Now easier to apply than ever...
Guaranteed to dry perfectly, while you wait

"MONEY-BACK" GUARANTY

Try one can of Rogers Brushing Lacquer. If not *more* than satisfied, return what is left to your dealer. He is authorized to refund the entire purchase price.

MORE than 20 millions of cans of "Rogers" sold since its comparatively recent introduction!

What a wonderful testimonial to the distinctive features of "Rogers"—to its *exquisite colors*—to its *ease of application*—to its *perfect fast-drying*—to its *great popularity* everywhere for utility and decorative purposes.

Anyone can use it successfully

No special experience is needed to apply these radiant, fast-drying "Rogers" colors. No tedious or expert preparation of the surface is required. Merely *flow* on the rich, glorious "Rogers" color with a full brush. Spread it out like a thin icing.

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"Rogers" colors, always of exquisite hues, are more beautiful *now* than ever. In smart homes everywhere they are the vogue. Do you wonder when you look into the open can shown here? Even in printer's ink the beauty of "Rogers" Chinese Red is alluring.

But *Chinese Red* is only one "Rogers" color. There are 25 others, all equally rich and radiant. There are unlimited tints, easily made by intermixing. There are also six wonderful *deep* colors especially recommended for hard outdoor use as well as indoor, not to forget the famous "Rogers" black, white and clear, and a new, transparent "Rogers" *especially for linoleum*.

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At dealers' everywhere

"Rogers" is now preferred and used nationally. Leading paint, hardware and department stores carry it.

However, to be certain of getting "Rogers" colors, easy application, perfect fast-drying and long service, *insist upon the genuine*. It comes only in the familiar "oriental" can shown here and has the name "ROGERS" on the label. You cannot mistake it.

Every can is sold on our nationally advertised "Money-Back" Guaranty.

DETROIT WHITE LEAD WORKS, DETROIT, MICHIGAN
Makers of Highest Grade Paints, Varnishes, Colors, Lacquers

Also distributed and guaranteed by: ACME WHITE LEAD AND COLOR WORKS, Detroit, Michigan; LINCOLN PAINT AND COLOR COMPANY, Lincoln, Nebraska; THE LOWE BROTHERS COMPANY, Dayton, Ohio and Toronto, Ont., Canada; THE MARTIN-SENOUR COMPANY, Chicago, Illinois; PENINSULAR PAINT AND VARNISH COMPANY, Detroit, Michigan; THE SHERWIN-WILLIAMS COMPANY, Cleveland, Ohio; THE SHERWIN-WILLIAMS CO. of CANADA, LTD., Montreal, Canada; LEWIS BERGER AND SONS, LTD., London, England, and Sydney, Australia; THE SHERWIN-WILLIAMS CO., London, England, and Sydney, Australia.

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Both of these questions are settled to your complete satisfaction if you select a Cadillac-LaSalle dealer as your used car merchant. For Cadillac-LaSalle dealers, because of the very nature of the new cars they sell, are in a preferred position to handle used cars. They offer an exceptional variety of types and models, representing nearly all the standard makes.

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These cars are offered to you by dealers who can be trusted for fair dealing, who follow a rigid policy in the merchandising of used cars, who want your good will and will take every precaution to deserve it.

They are also offered to you at fair prices because they were not overvalued when accepted as trade-ins. They are furthermore in good condition, capable of delivering many miles of service.

They are *good used cars*, well worth the money you invest in them—and the men you buy them from are the *kind* of merchants who are worthy of your patronage.

CADILLAC-LaSALLE

Cadillac Motor Car Co., Division of General Motors

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A Six Reel Movie on the Rise of the INVESTMENT TRUST

By WALLACE AMES, *Financial Editor*

A billion dollars is a lot of money. Within less than a decade, more than a billion dollars belonging to American investors have been put into investment trusts. Today several hundred investment trust companies are operating in the United States. These companies have become a dominant factor in the economic and financial structure of our country. Literally a new investment instrumentality has been placed at the disposal of the private investor . . . bringing within his reach opportunities for profit with protection against loss such as was heretofore known only to banks, insurance companies, and other institutional investors who control large funds and command extreme skill and elaborate facilities.

On the surface the American investment trust seems to have come into existence quite suddenly and to have developed with amazing rapidity. Is it a permanent development or just a passing style? By reviewing the underlying forces we should find the answer. In this way we may discover just what the investment trust means to the man with $100, $1,000, or $10,000 to invest.

EPISODE I

Until about fifteen years ago American investors owning bonds and stocks numbered but a few hundred of thousands. Today they are numbered in the millions. The World War was largely responsible for this change. First everybody bought Liberty Bonds. Then public utilities began distributing their preferred stocks to customers. And it became the vogue for industrial organizations to make partners of their employees by selling or giving them stock. Real estate bonds gained great popularity. The public's money invested in them helped finance construction of buildings and relieve the housing shortage.

Prices of everything advanced to a new level. Wages went up. Profits increased. Everybody had money—money to invest. We became a nation of investors. We formed the investing habit.

EPISODE II

The natural result of this widespread public interest in investing was the establishment of thousands of new investment banking firms and investment departments in banks. Small cities and large ones each began to develop its own "Wall Street." Large amounts of capital were invested in these investment banking firms. Corps of security salesmen, research and statistical departments and other facilities were organized in the service of the new American investor.

Our enlarged investment banking machinery soon began to encounter difficulty in obtaining enough new issues of sound securities to supply the demand of its customers. Investment firms had no sales problem, but a serious production problem. New issues of bonds or shares were usually quickly over-subscribed. There were not enough new securities to go around. Needless to say, an investment house cannot remain long in business and maintain its overhead without securities to sell.

The organization of an investment trust gives the security house the equivalent of a new issue to offer to its customers. But the investment trust itself is not embarrassed through the shortage of new securities above mentioned. It may invest its funds in old securities, those which may have been issued ten, twenty, or fifty years previously, which it purchases in security markets all over the world.

EPISODE III

Following the war America became the world's largest creditor nation, a position formerly occupied by England. Our people had more money than was required to finance our own development. Other nations were not so bountifully supplied. To keep our surplus money profitably employed it was necessary for us to loan to foreign nations; they were forced to borrow to finance rehabilitation.

The American public is not naturally internationally minded. We may travel extensively abroad, but as investors we do not possess the familiarity with foreign financial conditions necessary to make investments wisely in foreign securities. Investment trusts, whose specialists do understand foreign conditions, can and do invest safely and profitably in other lands. Thus the investment trust became a medium through which surplus funds of individual American investors could be wisely invested abroad.

EPISODE IV

Right before our eyes American business and industry is undergoing a complete revolution. Just when it started is hard to say. Perhaps it began with the motor industry and paved highways. During the same period the electrical industry has accomplished wonders that make Aladdin look like a piker. Chemical developments are just as amazing. Distances have been diminished and days reduced to split-seconds by airplane, radio and telephone. Mechanical processes are replacing hand labor. Mass production is cutting costs. Chain store units . . . consolidations and mergers of railroads, utilities, banks, manufacturing and mercantile (Continued on page 5)

A Six Reel Movie on the Rise of the Investment Trust

(Continued from page 4)

enterprises . . . new relations between government and business . . . these are but a few manifestations of a new era—an era which has created record profits for modern corporations.

Having acquired the investing habit, the public naturally looked with eager eye on the profits of modern American industry. But those who were conservative sought a safe way to share in these profits. It was a tradition that bonds were the safe medium of investment; stocks were regarded as speculative. Yet it is the stocks, not the bonds, that participate in profits.

The investment trust became the medium through which stocks could be purchased with the greatest degree of safety. The average investment trust invests its resources in both bonds and stocks. By purchasing a large number of different securities it diversifies its risk and produces a degree of safety unattainable by the average individual of limited funds. Through ownership of investment trust shares the individual participates in all of the investments of the trust.

EPISODE V

Following the war, something happened to change the attitude of economists toward stocks. Today well selected common stocks enjoy an investment rating. The conservative investor who formerly confined his purchases to bonds today is a buyer of stocks also.

Take the case of Widow Tilson. In 1914 she had $100,000 invested in 5 percent bonds, from which she derived an income of $5,000 a year. Living costs went up. Today it takes $8,000 to maintain a living scale that could be done with $5,000 fifteen years ago. To get the $8,000 Widow Tilson either must increase her $100,000 principal to $160,000 and invest at 5 percent or raise the income on her original $100,000 from a 5 percent rate to 8 percent. Bonds do not grow in principal. Neither does their income yield increase. In contrast, the stocks of growing, prosperous business institutions do frequently increase in value and pay higher dividends.

From this statement the reader must not conclude that an investment in any stock will increase in value and in dividend disbursements. We refer to the general tendency of the better grade issues.

The public came to realize that investment income is nothing more or less than buying power. When living costs go up one needs more dollars to meet expenses. How to keep one's investment income in line with changing times has been a real problem since 1914. Through safe investment in stocks the investment trust has helped to solve this problem.

EPISODE VI

Although the American public cannot be accused of lack of confidence in itself, it has come to realize that investing is a business, a profession, calling for specialized training and special facilities. No longer is invest- (Continued on page 6)

A Six Reel Movie on the Rise of the INVESTMENT TRUST

(Continued from page 5)

ment of money regarded as a sideline in which any intelligent merchant, doctor, engineer, salesman or mechanic can engage without special training. This is the age of specialists . . . and investing is a specialty.

Trained investment counsel can be had . . . for a price. The man with a few thousand to invest cannot afford the services of such counsel. Investment trusts are under the management of investment specialists. The maximum of skill and facilities is at their command. The investor who owns as little as one share in an investment trust benefits by the skill of its management to the same degree as he would if he had 1,000 shares. When one studies this series of episodes and detects their relation to each other, it is easy to understand that the investment trust is the logical, natural result—probably the only development to be expected under the conditions outlined. There were investment trusts in Europe long before they started in this country. But even if they had never existed in Scotland, England and the Continent we would doubtless have them in America today. Considering the underlying facts, it is a safe assumption that the investment trust is here to stay.

An investment trust is simply a business. Its form or structure can be compared to that of any other business, a railroad for example. A railroad sells its stocks and bonds to investors and thus raises working capital. It then buys equipment, acquires its right of way and engages in the business of furnishing transportation. From the profits of its operations it pays expenses, taxes, interest on its bonds and dividends to its stockholders.

Similarly, an investment trust sells its own securities to the public. With the capital thus raised it engages in the business of making investments. With the profits of its investment operations, like the railroad it pays expenses, taxes, interest, and dividends to shareholders.

With huge resources the investment trust is able to invest in many securities, in many countries. It may obtain a degree of diversification far beyond the reach of the average individual. It is able to engage the services of experts and to maintain elaborate statistical and research facilities, perhaps at great cost, but this expense is infinitesimal in relation to each investor's dollar.

Regardless of the amount of his individual holdings, the investment trust gives each shareholder the power of large resources, allows him to share in the safety and profits of internationally diversified investment and gives him the benefits of managerial skill in place of amateurism and guess-work. It permits the investor to share in equity profits with minimum risk, as well as to benefit by diversified bond holdings.

In a development that has proceeded as rapidly as the investment trust has gone forward in this country, it is not likely that the securities of all such companies are good (Continued on page 7)

A Six Reel Movie on the Rise of the Investment Trust

(Continued from page 6)

Investments. We would advise Popular Science Monthly readers to investigate before investing. Study the provisions and restrictions under which the trust management operates. Investigate the reputation of the management. Invest through a firm in which you have confidence.

To Help You Get Ahead

THE Booklets listed below will help every family in laying out a financial plan. They will be sent on request.

"How to Build an Independent Income" is the title of a new booklet by the F. H. Smith Company which explains conclusively how people of moderate means may obtain financial prosperity. **"56 Years of Investment Service"** describes the history of progress of the F. H. Smith Company as well as making an attractive suggestion in first mortgage real-estate bonds. May be obtained by addressing the home office of The F. H. Smith Company, Smith Building, Washington, D. C.

The House Behind the Bonds reminds the investor of the importance, not only of studying the investment, but of checking up the banker who offers it. Address: Fidelity Bond & Mortgage Co., 1188 New York Life Building, Chicago, Ill.

"The Investment Trust from the Investor's Viewpoint," presents an explanation of this form of investment in easily understood terms, illustrated with some interesting examples of how the general investment trust will help the man with $100 or more to get ahead. Published for free distribution by United States Fiscal Corporation, 50 Broadway, New York. Ask them for Booklet IT.

How to Retire in Fifteen Years is the story of a safe, sure and definite method of establishing an estate and building an independent income which will support you the rest of your life on the basis of your present living budget. Write for the booklet to Cochran & McCluer Company, 46 North Dearborn St., Chicago, Ill.

How to Get the Things You Want tells how you can *use* insurance as an active part of your program for getting ahead financially. Phoenix Mutual Life Insurance Company, 318 Elm Street, Hartford, Conn., will send you this booklet on request.

The Guaranteed Way to Financial Independence tells how a definite monthly savings plan will bring you financial independence. Write for this booklet to Investors Syndicate, 100 North Seventh Street, Minneapolis, Minn.

The Making of a Good Investment tells how 6½% can be made on investment in First Mortgage Bonds in units of $50, $100, $250, $500 and $1000; how the bonds are protected and how simple it is to purchase them. For a copy of this booklet address United States Mortgage Bond Company, Limited, Detroit, Michigan.

The Investment Trust from the Investor's Viewpoint is a booklet describing the investment trust in non-technical language, published by Smith, Reed & Jones, Inc., 1405 Chase National Bank Building, New York. This booklet explains how both earning power and safety are applied to moderate sums of money through the instrumentality of the investment trust.

"Money Doubling." This newly published pamphlet describes a feasible plan whereby the investor may double his money in less than six years by accumulating the stock of Financial Investing Co. of New York, Ltd., which he receives as quarterly dividends. It will be sent free on request addressed to Smith, Reed & Jones, Room 1408, Chase National Bank Building, New York.

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Popular Science GUARANTEE

POPULAR SCIENCE MONTHLY guarantees every article of merchandise advertised in its columns. Readers who buy products advertised in POPULAR SCIENCE MONTHLY may expect them to give absolute satisfaction under normal and proper use.

Tools, Radio Apparatus, Oil Burners and Refrigerators advertised in POPULAR SCIENCE MONTHLY have been tested or investigated by the Popular Science Institute of Standards and each advertisement carries the insignia indicating approval.

However, other products advertised in the magazine not subject to test carry the same guarantee to readers as products tested.

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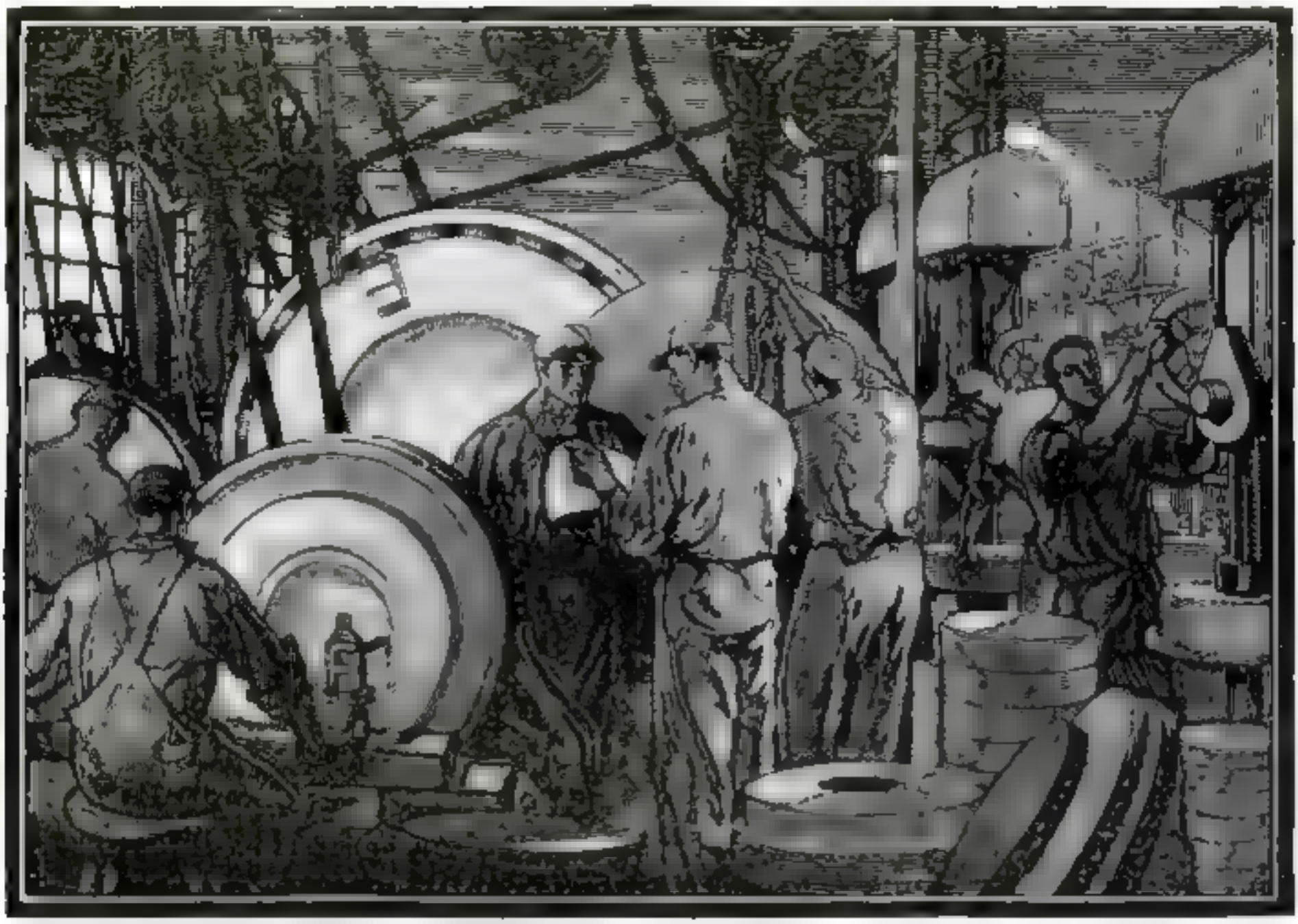

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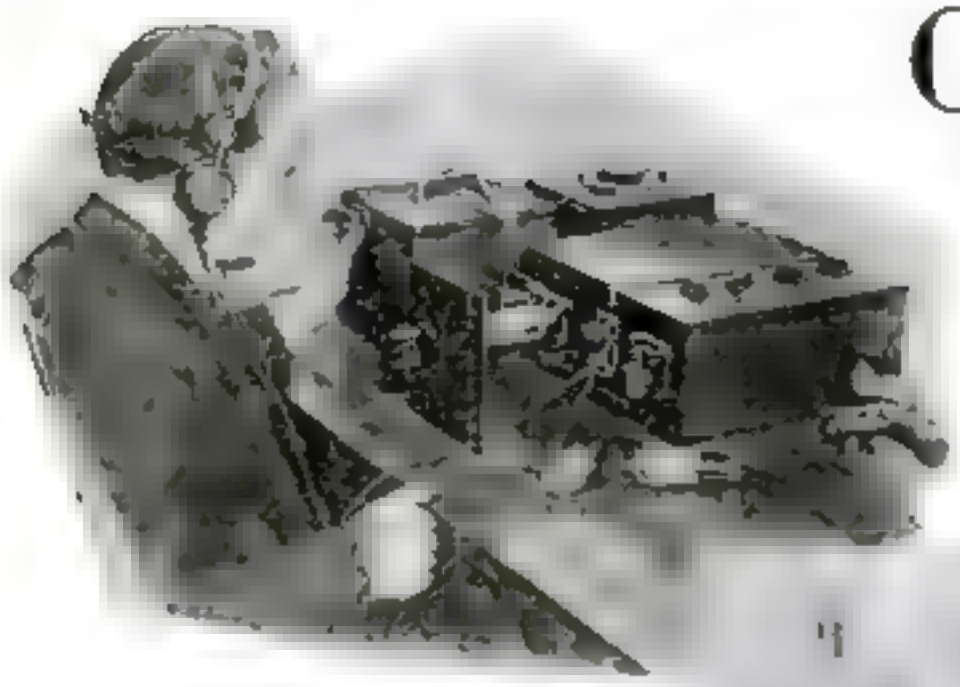
Only High-Grade Tubes Survive

By

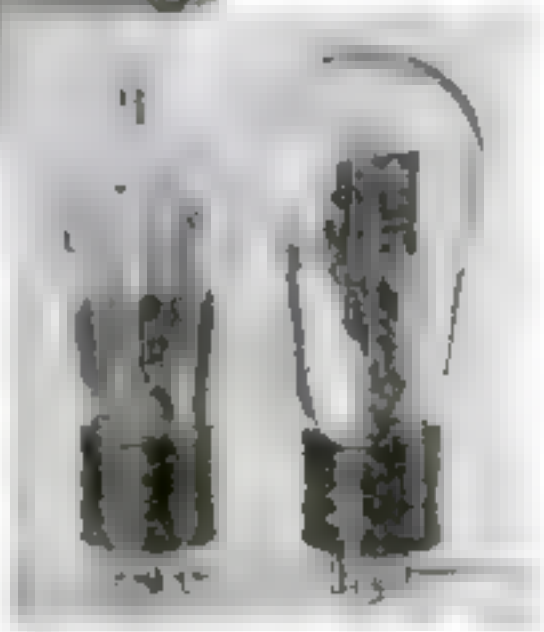
F. G. PRYOR

Secretary, Popular Science Institute



Testing various types of radio vacuum tubes in the radio laboratory of the Popular Science Institute.

Tests in the Institute Laboratory Show That Inferior Amplifier and Rectifier Tubes Break Down Under the High Power of the Modern Electric Receiving Sets



At left, UV 224 type A.C. screen grid tube. Right, UX 245 power amplifying tube.

SEVERAL days ago a radio vacuum tube was placed in a test circuit in the radio laboratory of the Popular Science Institute of Standards. There is, of course, nothing unusual about that, because a number of tubes are tested every day in the Institute laboratory. But the action of this particular tube shows what may happen if you are careless about the make of tubes you use in your radio receiver.

The tube placed in the test circuit was a full wave rectifier tube. In appearance it looked exactly like other high-grade tubes of this type. In fact, the only way it could be told from other makes was by the maker's name and type number on the base. The current was turned on. The tube's filament glowed in the usual manner and test readings were taken immediately. According to these readings the tube was a good one. Its current output was up to standard, and if, as is the common practice in radio stores, the tube had been taken out of the socket at once, it would have been passed over the counter as a perfect tube.

HOWEVER, Popular Science Institute of Standards tests are far more searching than that, and consequently the current was left turned on and the tube was kept under careful observation. Thirty seconds later the radio expert making the test noted that the tube filament seemed to be glowing more brightly, and before forty-five seconds had passed the filament had reached a temperature so high that the tube began to take on the appearance of an electric light bulb rather than a radio vacuum tube. Fifteen seconds more went by. Then the filament fused and broke. One of the loose ends of the ruptured filament dropped over against the plate, and for several seconds thereafter there was a beautiful display of flashing blue, red, and green light that finally disappeared, leaving the tube a useless piece of glass fitted to a handsome bakelite base.

Every other tube of the same type from the same manufacturer gave out in the same way. Some lasted as long as two or three minutes; others quit the job in less than thirty seconds.

Needless to state, the name of the manufacturer of these tubes does not appear on the list of manufacturers of products approved by the Institute of Standards, for, if a tube of this type were placed in a full electric radio receiver, either the protecting fuse would be blown or, if the set had no protecting fuse, the power transformer would be burned out, resulting in an expensive repair job

MODERN radio receivers employ type 227, type 224, type 245, and type 280 tubes, and in most cases the tubes are operated at maximum capacity. It is difficult to manufacture tubes that will give long and satisfactory service when operated under maximum requirements.

It is relatively easy to manufacture a type of 280 full wave rectifying tube to handle the B current requirements of the earlier types of full electric receivers, but an imperfect tube that might have given six months of reasonably satisfactory service in an older type of electric set probably would give out in less than a week in a modern receiver.

Although the internal construction of a vacuum tube does not look particularly complicated, great care and precision must be used in all the manufacturing processes involved, in order to obtain the most satisfactory results from this sort of tube.

A good tube of any type is one which on test will match with the standard requirements and is free from undesirable characteristics such as insufficient evacuation, sources of unwanted electron emission, and impaired emission from the cathode or filament, depending on the type of tube.

Insufficient evacuation, of course, means a poor vacuum, and, if the manufacturer does not pump out the maximum amount of air and also get rid of the gases embedded in the surfaces of the elements, the tube will be erratic in operation and short lived.

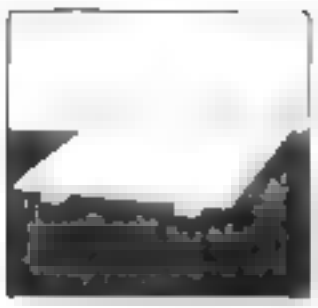
IN A vacuum tube there should be a copious flow of electrons from the filament in the case of the type 245 power amplifier tube and the type 280 full wave rectifier tube, and from the cathode in the case of the type 227 heater A. C. tube and the type 224 A. C. screen grid tube. There should be no electronic flow from other elements in the tube. If, for instance, there is in the type 280 tube, a flow of electrons from the plate, there will be a heavy reverse current which will result in overloading the filament and burning it out. In tubes like the 224 or the 227, where the cathode is indirectly heated by the filament (the latter taking no part in the electrical functioning of the tubes), care has to be taken that the extra heat thus required does not overheat the other elements in the tubes and cause unwanted emission. In these tubes the construction also is much more complicated than in the simpler tubes formerly used for battery operation, and in order to obtain proper results the elements must be spaced with an extreme degree of accuracy

Furthermore, the handling of the tubes during assembly to prevent deforming the delicate structure must be done with considerably greater care. When you stop to consider that in older types of battery-operated sets a receiver that used forty milliamperes in the B circuit was considered a "hog" for current, and compare it with the modern receiver in which B current may be more than 100 milliamperes, it is by no means difficult to see that the type 280 tubes used in modern receiving sets must be up to standard in every way.

This year, more than ever before, it is vitally important to follow the impartial recommendations of the Popular Science Institute of Standards in purchasing radio vacuum tubes as well as other radio apparatus.

How Presdwood is used in making the cores for engine cylinder castings

Only those who have tried out Masonite Presdwood can really understand how a grainless wood board can improve products and lower manufacturing costs. That is why a sample of Presdwood is gladly sent, without obligation, to executives who are interested in improved production methods.



FOR CORE TRAYS IN FOUNDRIES

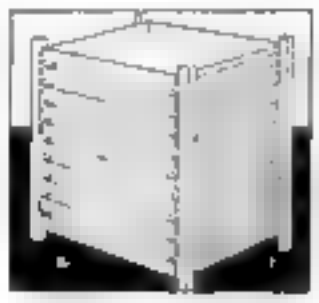
In many of the finest foundries, where white hot streams of molten iron are being transformed into automobile cylinder blocks, you will find cores for the molds being baked on grainless wood boards of Masonite Presdwood. They are boards which are highly resistant to warping, even when exposed to wet sand cores and scorching temperatures that run up to 450 degrees.

The Lakey Foundry and Machine Company of Muskegon, Michigan, is just one such progressive concern where Presdwood is being used for this purpose. In competition with steel plates and other materials, this grainless wood was adopted because of its lightness, strength, hardness and smoothness.

For simplified manufacture

Industry after industry has turned to Presdwood to improve products, lower costs or simplify production methods. Presdwood is used for starch trays in candy factories. It makes sturdy sides for specialty shipping containers, outer panels for incubators and iceboxes, hulls for fast speed boats, weather resisting road signs, side panels for motor truck bodies, light toys, bedroom screens and a score of other useful articles.

Presdwood has no splintering edges to mar the finished work that is done in a factory or to bother the mechanic who uses it around the home. This grainless wood can be punched, die cut, milled or sanded. It can be sawed, planed or cut with a knife. Presdwood does not split or crack; is chosen by production executives, enjoyed by men and boys who like to make things.



FOR STARCH TRAYS IN CANDY FACTORIES

In buildings and homes—for paneling

Presdwood panels fine homes and buildings of the most modern kind. It takes any commercial finish or can be left just as it comes, for it is naturally attractive as well as moisture resisting. It makes decorative floors and backgrounds for show windows, is used at Hollywood for the construction of moving picture sets. There are, in fact, so many striking and varied uses for this grainless material that a booklet has been written which describes eighty of the most interesting uses and attractively illustrates many of them.

The booklet and a sample of Masonite Presdwood may help you find a way to use this grainless material to cut production costs or improve a product. The sample and booklet are yours for the asking. It takes but a postcard to bring them.

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Made by the makers of
MASONITE STRUCTURAL INSULATION

FOR MOVIE STUDIO SETS

Our Readers Say—

Heroes of the "Slab"

"I AM not knocking locomotive engineers, but after reading Arthur Grahame's story, 'At the Throttle of the "Big Hog,"' I am wondering if you realize the importance of a trade which is changing passenger transportation from railroads to motor roads, or the 'slab.'

"I happen to belong to that clan known as 'Bus Drivers.' We have as much, if not more, responsibility than any locomotive engineer in the United States. The bus driver takes his bus out of the station with from twenty to fifty passengers behind him and fights all kinds of weather on all kinds of roads—some that are hardly more than cow paths. He has his $10,000 or $20,000 bus to look after in all kinds of traffic, and has to 'think quick and act quicker' to avert accidents.

"I have been on runs that have a forty-mile-an-hour running schedule, and if I pulled into the division point over ten minutes late I was told, 'If you can't make it we have men with a bigger foot' (meaning men who could drive faster).

"If I were a word artist like Mr. Grahame, possibly I could write you a story of our men that would make good reading. Why does not POPULAR SCIENCE have Mr. Grahame do it?"—E. B. H., Topeka, Kan.

Who Can Match This?

"I CAN'T begin to tell you how interesting I found your series of rotogravure pictures which showed the early ancestors of modern automobiles. Well do I remember my first car, one of those first glorious Wintons, back in 1902. That was some car. Since then I have owned eight different machines, every one of which I have driven more than 25,000 miles. I claim this is a world's record for automobile ownership. Is there anyone who can challenge it?"—V. M. D., Lansing, Mich.

Thank You, Sir

"PERMIT me to give you my opinion on the question whether POPULAR SCIENCE should run more aviation news or not. First, I want to thank Mr. J. P. F., of Chicago, for bringing up this argument. I feel, now, that I will see more about such modern sciences as chemistry, physics, geometry, and television in place of aviation news.

"No sir, I am not interested in aviation as yet. Yes sir, I prefer the railroads to aeroplanes. I have never flown and do not want to fly. Indeed, sir, I would like to see very, very few articles on aviation. Of course, I enjoy reading an article on aviation, once in a great while, but when it comes to the latest, loud colors for planes and the proper way to fix a flat tire while five thousand feet above the ground, I, different from others, do not care for such news in the least.

"Moreover if I should become interested in aviation surely I wouldn't look up to POPULAR SCIENCE for all the news. I would pick a magazine which contained nothing but 'Sky High' articles.

"I hope that you understand my point clearly and that there will be a big cut in the space devoted to aviation."—S. F., Madison, N. J.

Might Try It, Lieutenant

"AFTER reading the article 'Climbs 722 Feet Nearer the Sun,' in which John E. Lodge tells of Lieut. Apollo Soucek's high altitude flight in the *Apache* I desire [illegible] that Lieut. Soucek might try out as another flight in the same plane.

"When he reached his limit of climb and the plane hesitated, stood on end, and whirled toward the earth, had he been equipped with a plane having wider propeller blades, the other factors being the same, he would have been enabled to catch more volume of thin air and go a little higher.

"My suggestion is that he replace the present propeller blades of that *Apache* plane with blades having, say, twice the area, and although the propeller's weight will be increased proportionately, I 'guess' that the *Apache* will go higher, at least 722 feet more than before. In taking off and rising, while in normal air, he may desire to offset the change by utilizing less than usual speed and then get all the advantage possible from the widened blades, say, above 10,000 feet altitude, when his supercharger is giving desired effects."—N. G. W., Gallipolis, O.

A Matter of Type

"I THINK you could afford to use more type on aviation, and less on how to build furniture."—G. A. P., Chicago, Ill.

Ship Ahoy, Girls!

"I HAVE finished the *Mayflower* model from your blueprints and desire to thank you for the inspiration to make it and for the help of the articles and prints. Apart from being a beautiful ornament, my boat has developed a useful role. One friend, a school teacher, asked to borrow it for a history class. I let him have it and he told his pals. It is sailing for a big girls' school tomorrow on its next trip. You may like to know that my total expenditure for the *Mayflower* was just eight shillings—less than $2. Needless to say, I made every block myself. A dealer has valued it at 50 pounds, over 120 times its cost."—S. C. H., Fishponds, Bristol, England.

I have followed your models in POPULAR SCIENCE for some time and have built the Spanish galleon and the *Constitution*. The former sold for $30 and the latter for $15. I am going to build your racing yacht model next. I have POPULAR SCIENCE from January 1926, every copy and enjoy getting them out and reading them every so often."—C. F. S., Chicago, Ill.

Here's Another Worry

"IF YOU will open a can of peaches or a can of any other fruit containing a clear syrup of high specific gravity and examine the surface of the liquid while holding the can in bright sunlight you will notice from ten to thirty little glittering specks of metal ranging up to the size of a pin head.

"These specks are produced by the can opener as it cuts open the lid. All consumers of canned foods, unless they take the trouble to scrape off the top of the contents of the can before emptying it, are taking into their systems a quantity of metal. I do not know if these little particles have anything to do with appendicitis, because of their possible lodgement and irritation in the appendix, but I do believe they must be harmful to the system.

"I believe manufacturers of canned goods should use only cans equipped with tongue and key levers like those used to open sardine cans and canned meats, and lately adopted by certain salmon packers. Let's ask all manufacturers who sell their product sealed in cans."—O. H., East Vaughn, New Mexico.

Let's Ask Einstein

"YOUR article on perpetual motion by Edwin W. Teale assumes that such a thing is impossible and sets forth reasons why all attempts at inventing perpetual motion machines must fail. For a magazine which is constantly reminding its readers of Inventors who have 'done the impossible,' isn't this a rather illogical position to take?

"Just because the U. S. Patent Office says that perpetual motion is impossible, does that make it so?

"Assuming that some day it may be possible to insulate against gravity, as indicated by Einstein's latest discoveries of the relation of electricity and gravity, would it not be entirely possible to invent an overbalancing perpetual motion wheel, one side of which was insulated against gravity, the other side not? What would prevent such a wheel from running forever? I want to know."—S. P. N. R., Dayton, O.

From A Church Pastor

"LAST winter I began to cast about to see if I could not find some way in which to make my Sunday evening service different, with the idea of increasing the interest and also the attendance. I fell on the plan of giving a ten minute talk before the sermon, and these I call 'Talks on the World About Us.' My files of the 'P. S.' have already given me a number of these and will give me many more. People seem to be enjoying them and a number have told me not to discontinue them whatever else I may do."—E. P. A., Vale, Ore.

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If you want a real treat in face comfort, do this tomorrow morning after you shave: Simply douse full strength Listerine on your face.

Immediately you note a glow of health—a tingling, zippy sensation that wakes up your skin.

Then, as Listerine dries, a wonderful feeling of coolness, as though a moist sea breeze were blowing against your cheeks. Gone that feeling of rawness. Gone that burning sensation.

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Some men are so delighted with the freshening effect of Listerine on the face that they employ it before important engagements at which they must look their best. Try it yourself sometime. Lambert Pharmacal Company, St. Louis, Mo., U. S. A.

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MONTHLY

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Adventuring with Rockets

WHO, young or old, does not respond to the thrill of fireworks, and of the skyrocket most of all?

Exciting adventures of Prof. R. H. Goddard, and of his nine foot rocket that scared Worcester, Mass., into thinking a falling meteor had exploded, are a part of a project that captures the imagination. His plan to shoot one of the fiery projectiles so high that it may even leave the earth forever, described elsewhere in this issue, savors of a Jules Verne romance. Yet his is a sober, scientific purpose—to study the weather two hundred miles or more aloft. While others have talked of shooting rockets to the moon, Professor Goddard's success thus far proves him the most practical of the lot.

Professor Goddard is an inventor of no mean ability. At present the high-altitude rocket is but one of his remarkable projects. He has just revealed that he is working upon a device of possibly revolutionary importance, as novel in the field of power as is his rocket in the study of high-altitude weather. POPULAR SCIENCE MONTHLY is privileged to present Professor Goddard's own description of this extraordinary invention in a coming issue.

Health Lamps—or Mustard Plasters?

WHAT a shock it must have been to the makers of health lamps in this country, and to a number of medical authorities as well, to hear the British Medical Research Council recently declare that the only difference between light treatment and mustard plasters was that mustard plasters were cheaper! Referring to popular interest in the use of electric lamps in the home to produce the rays of artificial sunlight—including the invisible "ultra-violet" rays that have certain curative powers—the Council declared:

"When conditions between children with and without (light) treatment are equalized, the result of light treatment is wholly negative."

Perhaps that statement might better have been left unpublished. Casually read, it is only too easily interpreted to indicate that so-called health lamps, in plain language, are "no good." If this is the real belief of the Council, it is certainly in direct contradiction to learned medical opinion on both sides of the Atlantic—as exemplified by the widespread use of "sun lamps" in hospital clinics, and, recently, for the treatment of the British sovereign himself.

The facts are, most authorities agree, that lamps generating ultra-violet rays have definite therapeutic value, notably in rickets; also that their exact physiological effect is still far from perfectly understood. It would not be surprising that many physicians, seeing laymen welcome the lamps as cure-alls for every conceivable body ailment despite ignorance of their limitations and positive dangers in careless hands, should deprecate a new form of treatment that unquestionably deserves much more careful research than it has received.

A Real Endurance Test

MAN or machine—which will outlast the other? That was the question crowds at a St. Louis, Mo., flying field asked recently, while overhead soared a plane which had been aloft so long that its official barograph had run down and it had to be timed by observers on the field.

When Dale Jackson and Forrest O'Brine, the plane's two pilots, finally obeyed an order to land after having been in the air more than seventeen days, the contest was still a draw. The men were fresh and walked on steady legs despite their two-week confinement in the plane's small cabin. The plane, and its motor, too, were in perfect condition to fly indefinitely.

Eventually the rivalry between human flesh and machine steel will be settled by other adventurers in the air. Should it then appear that man is inferior in stamina to his motors, endurance flights can be removed from any possible classification as impracticable stunt flying by this simple expedient:

Let relief crews of pilots be sent aloft to replace the men in the cockpit from time to time so that the flight will last long enough to be a thorough test of the motor. It is entirely possible to do so, more than once men have transferred from one airplane to another in full flight. Then the result will be a real test of a motor's stamina.

The New Chemistry

WHAT is colloid chemistry? And, excepting always the chemist in his laboratory, who cares?

Many-hued baths of gold solved a mystery of vital interest to give birth to colloid chemistry, a new explanation of the actions of familiar objects. Its name means literally "the chemistry of things like glue," and it deals with the curious properties of familiar substances when they are subdivided into particles of a certain very small size. It tells what makes chocolate-cake icing brown, how soap chases dirt, why shaving cream aids the razor. As told in an article elsewhere in this issue, never before were the things called colloids so important in the everyday life of the average man.

Hidden beneath such formidable names as "Brownian movement," "Tyndall effect," and "flocculation," fascinating events go on in the submicroscopic world of colloids. Why egg clears grounds from coffee, how jelly jells, and why stamps stick to letters—that is the domain of colloid chemistry. When a modern girl brushes her lips with lipstick that attaches itself with a pressure of 200,000 pounds to the square inch, even that is a triumph of the colloid chemist.

Everyone uses this new chemistry, though few understand it.

They are Saying—

"WOMEN are less troubled by disturbing dreams than men, probably because they have less work and worry."—Dr. Bernard Hollander, British alienist and criminologist.

"Dismiss the idea that natural law may swallow up religion. It cannot even tackle the multiplication table singlehanded."—Prof. A. S. Eddington, Cambridge University physicist.

"Scientists need to present the facts so that the public can understand and emotionally believe them. The public knows about science, but does not actually use it."—Dr. Otis W. Caldwell, director, Institute of School Experimentation, Columbia University.

"A tissue that has died can no more be restored to life than can new elasticity be put in a pair of worn-out suspenders."—Dr. Morris Fishbein, secretary, American Medical Association.

"The next logical development of airplane duration tests should be endurance flights over present or proposed commercial air routes."—Maj. C. M. Young, Acting Assistant Secretary of Commerce for Aeronautics.

"The world does not require faster and more neurotic persons, but urgently needs more accurate and dependable ones."—Dr. Lloyd Mills, Los Angeles, Calif.

Rob yourself of sleep . . .

but you can't rob the Gillette Blade *of its sure, smooth shave*

A FACE drawn and tight from lack of sleep, a slapdash lather and a hurry-up shave—it can't ruin the even temper of a Gillette Blade, even though it may wreck your own!

On such mornings lather extra thoroughly and treat yourself to a fresh Gillette Blade. You're sure then of the smooth, even, comfortable shave which has been honed and stropped into *every* Gillette Blade by machines adjusted to one ten-thousandth of an inch.

Every Gillette Blade *must* be even and sure. To guarantee that, four out of every nine of our blade department employees are inspectors and are paid a bonus for detecting every blade that won't do a superb job of shaving.

THE only individual in history, ancient or modern, whose picture and signature are found in every city and town, in every country in the world, is King C. Gillette. This picture and signature are universal sign-language for a perfect shave.

No two men have identically the same kind of beard. No man gives his Gillette the same kind of job to do every morning. A dozen varying conditions affect the comfort of your shave. The Gillette Blade alone remains constant.

Eight out of ten American men count on the Gillette Blade to do its job *well* every morning. It does. Witness the smooth faces of American men today. Gillette Safety Razor Co., Boston, U. S. A.

Gillette

Popular Science MONTHLY

OCTOBER, 1929 TRAVIS HOKE *Editor* VOL. 115, NO. 4

Barnstorming *with* Lindbergh

HERE, for the first time, "Slim's" old pal and flying partner relates one of the most colorful yet least known chapters in Lindbergh's career. With intimate, human anecdotes, he recalls the care-free days of 1924 when "Slim" wing-walked with him, or shared the thrills of a dead-stick landing.

Randy Enslow is known today as one of the most skillful of American pilots. Readers of POPULAR SCIENCE MONTHLY are well acquainted with him as the flying instructor who helped Larry Brent to find his wings. His simple, straightforward narrative is perhaps the most extraordinary Lindbergh story ever published.

By RANDY ENSLOW

LINDBERGH and I started barnstorming by accident. It was this way. We were both living in St Louis in 1924. He had sold an old war-time "Jenny" to a boy living up at Oelwein, Iowa. The kid gave him a deposit of twenty-five dollars, or something like that, and flew off home. He was supposed to send some more money each month until the plane was paid for. When nothing came from Oelwein for three months, "Slim" asked me to fly him up to see what was the matter.

I had built a J-1 Standard, the type of ship the Army used to train pilots on before the war. It was built with homemade spars, a secondhand engine and rusty fittings that I painted over. But it flew like a bird. When we climbed aboard, we didn't have much money in our pockets. We never did in those days.

AT OELWEIN, we found that the boy had gone off as a traveling violinist with a carnival. His mother had sold the "Jenny" for five dollars. She said she was afraid somebody would get hurt by the propeller. The buyer had come down in a perfect one-point landing—right on the nose—the first time he tried to fly the ship, and it was a total wreck. So we started barnstorming to pay for the trip.

Our stock in trade was carrying passengers. But we would do stunts and wing-walking and put on little one-plane air circuses of our own. We did everything that would bring in dimes. Sometimes we would race automobiles at country fairs. We got $75 for each race. Above those little half-mile dirt tracks we would have to bank the plane almost straight up and down and buzz around like a fly in a bottle. As I remember it, we always won. But we used to throttle down the motor until the last lap to give the spectators a run for their money. On that last lap, we would show the boys what the ship could do.

Randy Enslow and his plane, when he was barnstorming with Lindbergh. Right: When "Slim" tried to retrieve the oil can that jammed the throttle.

ONCE we flew into a town with "Slim" on the wing. When we landed, an old lady came up and asked: "Which one of you young men was that out on the fender?" "Slim's" favorite joke in those days used to be the one about the farmer who saw a pilot crack up in his cornfield and wipe off the landing gear and break the propeller. The farmer's wife asked her husband what happened. "Oh, not much," he said, "he just broke the truck and the paddle."

From Iowa, we barnstormed down into Missouri and then over into Illinois, spending most of a year at it. After I'd been out on the road for a week with "Slim," I always investigated a bed before I jumped into it. If I didn't, I usually sat down on a cocklebur or had June bugs crawling up my back. I got so I kept an eye on him during the day. If I saw him stoop over

Randy. Cross-country ace of the Curtiss Flying Service and one of America's foremost pilots.

and pick up anything as we walked across a field, I knew it was another cocklebur or bug, and governed myself accordingly.

On one of our barnstorming trips we left St. Louis with seventy-five cents between us. "Slim" flew the ship down to Greenfield, Mo. The school children heard us buzzing around overhead just before recess. When we landed, it broke up the school. All the kids came out and a bunch went up for rides. After a while the teachers and the townfolk came along and went up too. We would take turns at the stick. By night, we had a hundred and seventy-five dollars. I'll never forget how "Slim" dumped it all out on the bed in the hotel. The pile looked as big as a strawstack.

At night, we would stake the ship down, or tie its tail to a stump and leave it backed into the wind like a Missouri mule. One time, when we left it tied down like that in a field in Illinois, a tornado came through the country and headed right that way. But just before the twister reached the spot, it gave a jump and came down several miles beyond. The ship wasn't even scratched.

ON THE trips, I used to take along a mouth organ to play in the hotel rooms at night. "Slim" used to hide it every chance he could get. He was afraid I would keep the other people awake. He used to have a tough time getting me out of bed in the morning until he invented a "booster." It was a little electric generator with a wire attached. "Slim" would slip the wire between my toes and turn the crank. He always managed to get outside the door before I could reach him.

One night, we stopped at a town where I had friends. I made a date with two girls for "Slim" and me. When the time came to go out, he had disappeared. I had to take both girls myself. When I got home, he was sound asleep and the next morning he got me up with his "booster" just as though nothing had happened.

Knowing the way he loves a practical joke, I can imagine how he enjoyed giving the reporters the slip on his honeymoon. He let me in on some of the fun. I was one of the handful who knew he was out in his motorboat when the papers were reporting him in a dozen places at once. I flew his Falcon plane from Curtiss Field as though to meet him, to throw reporters off the scent.

As soon as I climbed into the cockpit to warm up the motor, a fast Fairchild Wasp was wheeled out of a hangar behind me. When I took off, the Fairchild was right on my tail, carrying newspapermen. I headed north over Long Island, gaining a couple of miles an hour on the Fairchild. I kept climbing for altitude, watching a fog bank that was rolling in below. About thirty minutes out from the field, I did a wing-over, dove into the fog and headed back toward New York, flying blind. When I thought I was nearing the big buildings, I zoomed up out of the fog and looked around. Nobody in sight. So I scooted for Schenectady and started the papers off on another wrong lead.

I have seen Lindbergh half a dozen times since he flew to Paris. Each time he has been the same old "Slim." If he has changed at all, it isn't in the direction of forgetting his old friends. That I know.

We always flew into a town with one of us out walking on the wing to attract attention. Then we would throw out a couple of hundred little handbills, printed on yellow paper. We had worked out the wording together. It read

COME OUT AND GET ACQUAINTED

THIS SHIP IS MADE OF WOOD AND WIRED TOGETHER

THE WINGS ARE NOT COVERED WITH TIN

IT DON'T BACK UP

THEN we would land in a cow pasture or baseball park and invite passengers to go up at five dollars a ride. If nobody went up, we would fly away. Later, we would come back. When the people saw they couldn't keep us unless somebody went up, they got air-minded and climbed into the cockpit.

I remember one time we were coming into a little town near Macon, Mo. "Slim" was doing his stuff out on the wings. We usually circled around a place two or three times to get everybody out and then came down in a careful landing to impress people with the safety of flying.

This time, we kept on circling. "Slim" looked over to see why we didn't go down. I made motions, pointing to the throttle. He crawled in to see what was the matter. I shouted in his ear:

"The throttle's stuck. Can't shut the motor off."

So "Slim" crept to the front of the wing and poked his hand in back of the engine. He found a can of motor oil we carried for emergencies had jarred under the throttle arm and wedged. He tugged and pulled, but couldn't get it out. He told me to cut the switch and down we came in a dead-stick landing.

BUT that was nothing new. We were always making dead-stick landings. The only instruments in the old Standard were a tachometer, an altimeter, and an oil pressure gage. And sometimes they didn't work. Water would get into the gas tank, or maybe dirt—we couldn't take any too good care of the ship oftentimes—and down we would come with a dead engine.

The toughest forced landing I ever made was my first. "Slim" and I were flying over rough country in Iowa when the motor quit cold. The only level spot under us was a sink hole about ten or twenty feet below the rest of the ground. It contained less than two acres and there was a big strawstack right in the middle of it. I had to side-slip in and then ground-loop around the stack to keep from cracking up the ship.

We always flew from one town to the next with the wind. It saved time and gas. We would go to bed planning to jump to one town in the morning, and if the wind changed during the night we

"We always flew into town with one of us walking the wings to attract attention."

"To get me up, 'Slim' would slip his 'booster' wire between my toes and turn the crank."

would go to some other town in the direction the wind blew. Wherever we went, we always "blew in."

Once, when the wind was blowing toward St. Louis, we flew home. We were dead tired when I set the ship down about dark in a field across from our house. A. W. Moyer, who has been my step-dad since I was eighteen months old, heard us come in and headed for the kitchen. He had a big skillet full of eggs frying on the stove when we came in the front door. "Slim" flopped down on the Davenport, with his legs hanging over one end, and I sat down beside him, propping my head up with one hand, to wait for supper. We tried to stay awake, but we both passed out before the eggs were cooked.

"SLIM" was the cleanest fellow I ever knew. He didn't smoke or drink or swear. He had more nerve and could do more with an old crate than any flyer I've seen. The greatest exhibition of nerve in the air I can recall was the time "Slim" came closest to being killed.

He was testing a new ship for Ben Bell in St. Louis. I stood in front of one of the hangars watching him. At 3,000 feet, he tried to put the plane into a right spin so the torque, or twisting force, of the motor would help him get it out. He tried three times, but couldn't get it to spin. So he put it in a left spin and down he came. For a thousand feet, with the wires screaming so they could be heard a mile away, he struggled to bring the ship out of that spin. Then he crawled out on the fuselage back of his seat, hanging on like a leech, ready to jump with his parachute. But he didn't jump. He pulled himself back into the cockpit again and came down 1,700 feet more, trying to save the ship. He was only 300 feet above the ground when he jumped, but he wasn't hurt a bit.

We barnstormed around in winter as well as in summer. One morning when we woke up in a little place near Alba, Ia., we found the ship covered with snow, and icicles hanging down from the wings. "Slim" knocked a few off with a stick, and we started up. By the time we had flown ten miles, every icicle had been blown away.

In winter, we made more forced landings than in summer. The throttle arm ran through a little copper tube by the motor. Above it, a connection in the cooling system dripped water into this tube. That was all right in summer. But in winter the water froze solid with the throttle open. We would cut the switch and come down with a dead stick. "Slim" was usually elected to dig out the ice with his jackknife or to melt it with a match. Then up we would go again. One time we made five dead-stick landings in one day. We had to sit down in everything from back yards to cornfields. But it was great training. No flying experience gives more all around training than a year of barnstorming.

One of our last stands was a little town near the Mississippi, in Iowa. For a couple of days we hopped passengers out of a baseball field almost completely surrounded by billboards. The morning we left, "Slim" cranked the motor. It started off, sputtered, started again. Probably water in the gas. There usually was. I decided to take her up for a turn of the field before we started. I got over the billboards, all right, but the power was so low that I flew almost all the way to Monmouth, Illinois, to get enough altitude to turn around and come back and put in new gas. I guess "Slim" thought I had started off for a distance record.

When we weren't out barnstorming, we would be living at Lambert Field in St. Louis. Once we tried "baching it," living at one of the hangars at the field. Every so often we would get hungry for a real meal. My home was on a farm about a mile away. We would climb into the Standard and fly out for some of mother's cooking. After we had circled the house with the engine wide open as a signal that two hungry men were coming, we would set the ship down in the field across the road and make a break for the kitchen.

Once when Mrs. Lindbergh was visiting us, I heard her say to my mother:

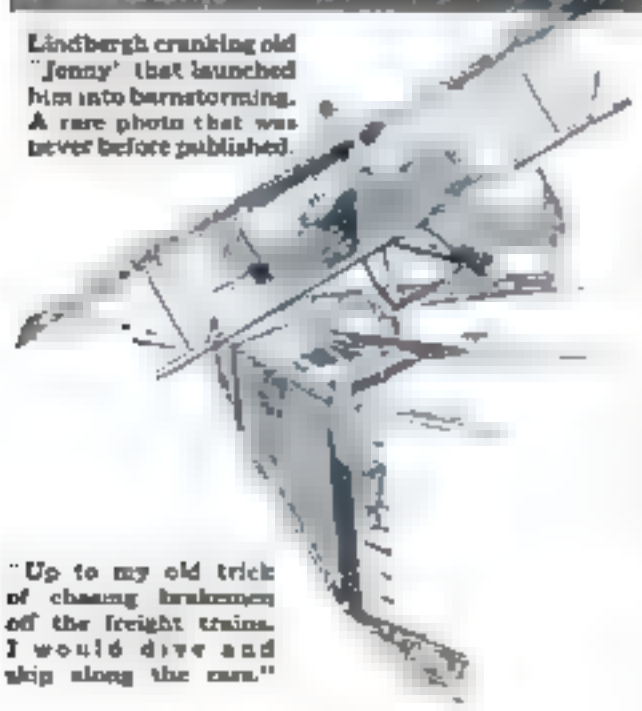
"I suppose the boys might get hurt flying. But they are careful and they want to do it so bad we will have to let them."

That part about being careful hurt my conscience a little that day. I had been up to my old tricks of chasing brakemen off the Wabash freight trains. I would dive down and skip along the cars while the trainmen scuttled down the ladders. It takes about 2,000 hours in the air to get over being foolish.

Lindy. "If he has changed at all, it isn't in the direction of forgetting his old friends," says Randy.

"Slim" dropped down on the Davenport and I sat down beside him, to wait for supper. We tried to stay awake, but we both passed out before the eggs were cooked."

Lindbergh cranking old "Jenny" that launched him into barnstorming. A rare photo that was never before published.



"Up to my old trick of chasing brakemen off the freight trains. I would dive and skip along the cars."

WHEN our year of barnstorming was over, "Slim" joined the air mail, flying the St. Louis-Chicago run for the Robertsons. We had cleaned up between three and four thousand dollars, and had not had a single crack-up. The next year I went out again, working Indiana and Ohio.

Later on, I sold the J-1 Standard we had used to an old fellow who was going to teach himself to fly. He took it up about fifty feet, slid off on one wing, and came down with a bump. He wasn't even scratched, but he was mad as a hornet. He took off his helmet and goggles, threw them on the ground and jumped up and down on them. Then he walked off and left the plane where it fell. That broke me all up. I didn't own the ship any more. But I hated to see her go that way.

Where the World's Fastest

UNUSUAL features in the design of the German steamship *Bremen*, new speed queen of the Atlantic, are depicted on these pages. They show why she was able to race into New York harbor, the other day, with a record-smashing mark of four days, seventeen hours, forty-two minutes from the French port of Cherbourg, and then, on her return trip, to lower the record between New York and Plymouth, England, to four days, fourteen hours, and thirty minutes.

On her westbound run the *Bremen* eclipsed by eight minutes less than nine hours the record of the *Mauretania*, which had held the speed laurels of the sea for twenty-two years. The *Bremen's* average speed was 28.2 knots—about thirty-two land miles an hour. In the eastbound crossing that followed she maintained an average of 27.9 knots.

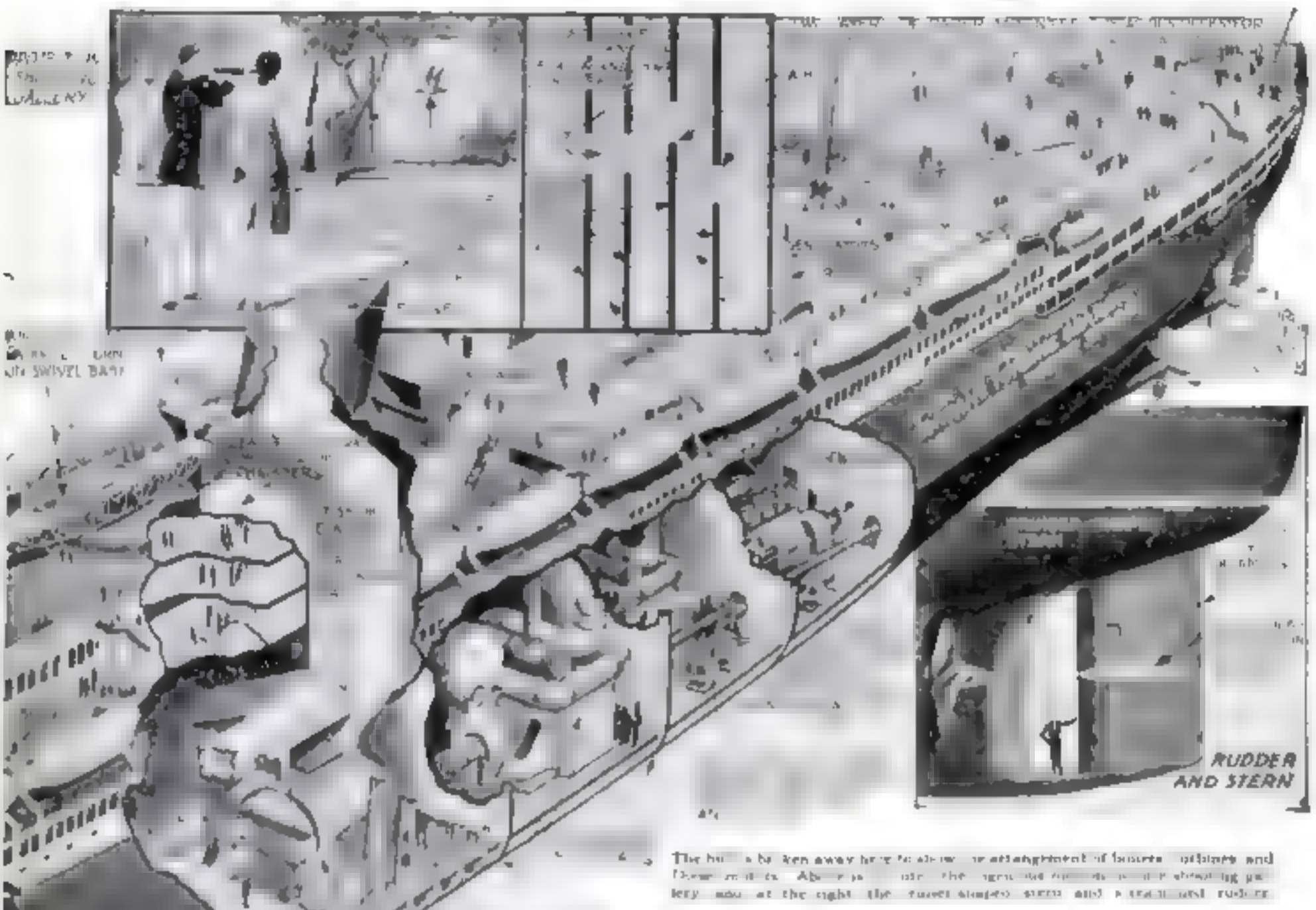
Fastest, most powerful, third longest and fourth largest merchant vessel in the world, the ten-deck *Bremen* is said to have cost $20,000,000 to build. She is a four-screw, 50,000-ton oil-burner with geared steam turbines, and can accommodate 2,200 passengers. Only the *Majestic* and the *Leviathan* surpass her length of 888 feet from stem to rudderpost, as vessels are measured for comparison.

Shipbuilding, as represented in the four-day *Bremen*, has made tremendous advances since the little *Savannah*, first ship to cross the Atlantic with the aid of steam, in 1819 sailed and steamed from Savannah, Ga., to Liverpool, England, in twenty-nine days. The German liner is a new departure in shipbuilding, even from the most modern of present-day vessels.

All exposed portions of the *Bremen*—even the funnels—are streamlined to increase speed. Upper inset shows new safety mechanism for launching lifeboats. An electric directory that aids passengers to find their way about the ship appears in lower inset.

Drawn for POPULAR SCIENCE MONTHLY *by B. G. Seabloom.*

Ocean Liner Gets Its Speed



The hull is broken away here to show the arrangement of boilers, turbines and [illegible]. Above is one of the open-air shooting galleries, and at the right the raked stem and streamlined rudder

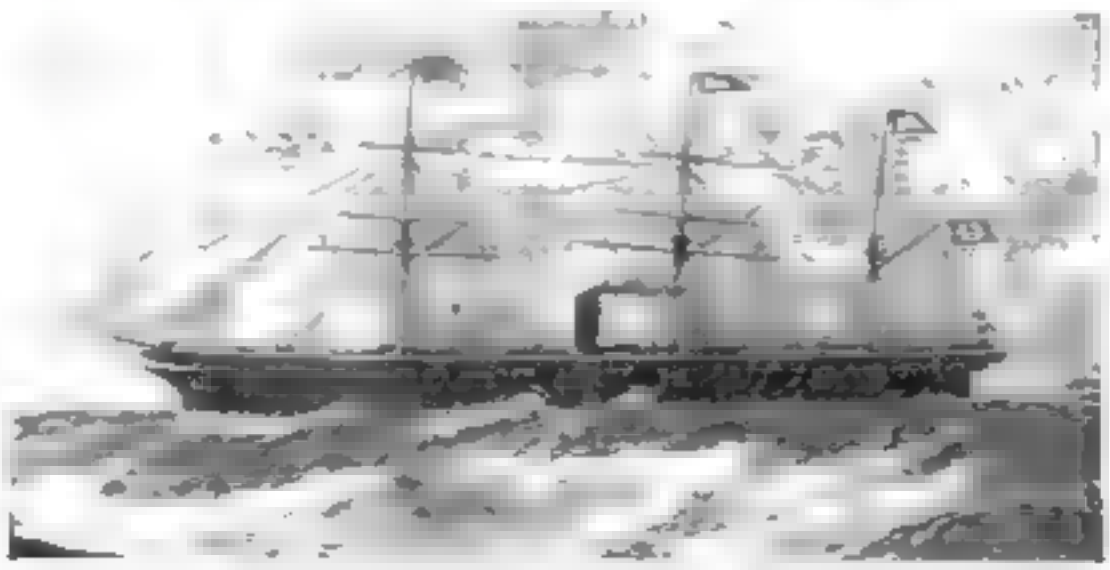
A BULBOUS bow that presses water down instead of to the side, a new style of streamlined rudder, and a cruiser stern lifted from the sea by the propellers helped the *Bremen* to earn the title of the fastest liner. Streamlined throughout, even to the funnels, the *Bremen's* curious shape, bulging in front and tapering behind, is designed to offer the least resistance to water and air. The shape assumed by a falling raindrop is applied to the funnels and, under water, in blisters—one on each side—which give the vessel her pear-shaped bow.

[illegible] special stern [illegible] pass [illegible] the most direct [illegible] and decrease [illegible]

[illegible] of 75 [illegible] or [illegible] for the [illegible] the [illegible] turbine machinery can attain 100,000 horsepower, the four smaller high-speed turbines that drive the *Bremen* develop a total of 130,000 horsepower at full speed and make it the most powerful liner afloat. They turn the four screws through single reduction gearings that step down the propeller's speed to one tenth that of the turbine shaft.

Innovations in passenger accessories are electric directories on each deck to help passengers find their way about the ship; decks that are unobstructed by ventilators; a remarkable shooting gallery with flying targets projected by a motion picture lantern, magnetic clocks in the staterooms, regulated from the navigating bridge, and a new type of steel davit that keeps the motorized, radio-equipped lifeboats out of passenger's way on the sun deck, ready to be launched instantly merely by pressing a button. A compressed-air catapult launches a mail plane from the top deck when the ship is near port.

Every modern safety device is present. Fourteen water-tight bulkheads make the *Bremen* practically unsinkable and the boilers and turbines are in two groups.

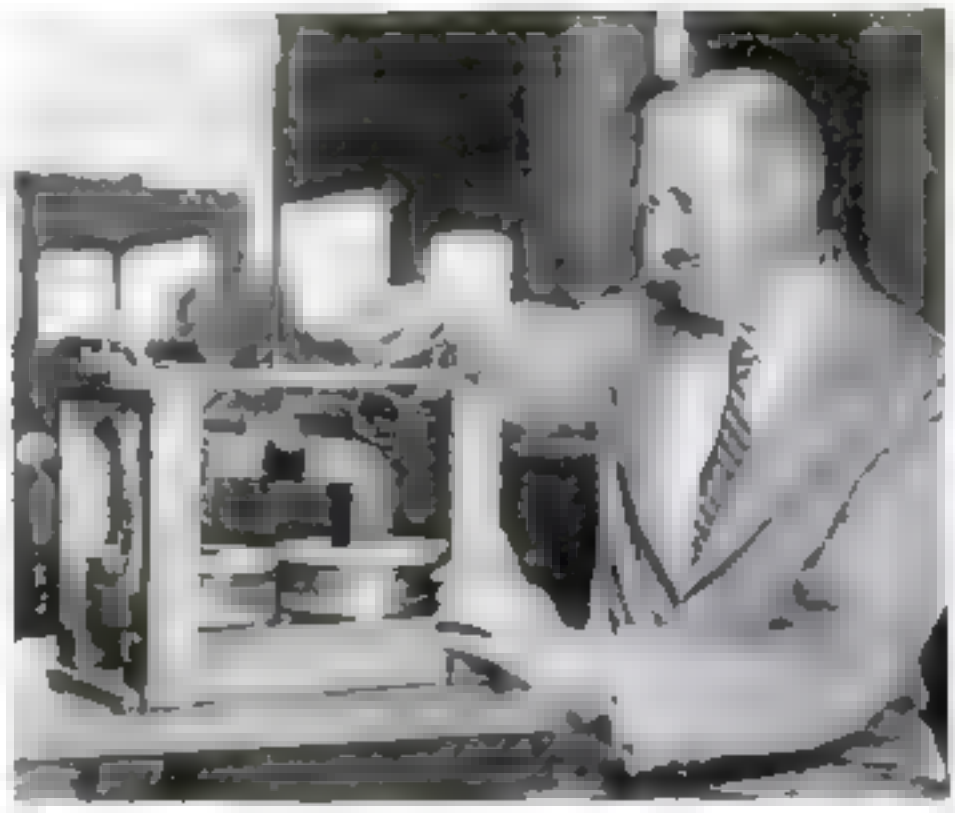


Seventy years of shipbuilding progress have evolved the luxurious new *Bremen* from this ancestor of steam and sail. This old-time S. S. *Bremen* was built for the same line in 1857.

Aims Rocket at Roof of Sky

Goddard Tests New Missile to Explore the Upper Air for Science

By ALDEN P. ARMAGNAC



Prof R. H. Goddard demonstrating the electric detonator with which he fired his rocket.

A SMALL group of experimenters carried a heavy cylinder of steel to the outskirts of Worcester, Mass., the other day. They set it on end at the base of a steel tower forty feet high at the center of a vacant field. Its shape revealed it to be a rocket—but such a rocket as a small boy might dream of the night before the Fourth of July It was nine feet high, and twenty-eight inches in diameter

The experimenters fitted the rocket on rails that ran up the sides of the tower, then retired to the safety of a small wooden shack a few yards away. One of them closed an electric switch. A spurt of flame shot from the rocket as it soared skyward

First reports from the astonished city of Worcester said that a huge meteor had exploded. Witnesses informed the Worcester police station that an airplane in flames had shot across the sky and blown up. Two police ambulances dashed through the streets looking for the supposed victims, while an airplane took off to aid in the search

The cause of all the excitement proved to be a test, by Professor R. H. Goddard, head of the physics department of Clark University, of a sky projectile that he invented to explore the upper air. A liquid propellant never before used in any rocket drove the latest model, which is the climax of experiments costing $12,000. With the new explosive Professor Goddard expects to shoot a rocket to heights never before attained. If one could reach a height of 200 miles above the earth it might obtain data of great value to science. Even a twenty-mile rocket would be an invaluable aid in answering the mystery of what is at the top of the sky.

Professor Goddard would equip high-altitude rockets to bring back four kinds of records—samples of the upper air for chemical analysis, measurements of temperatures and pressures in outer space, photographs of the sun's light far above the atmosphere, where the ultra-violet or "health" light is supposed to be much more intense than at the earth's surface, and observations of high-altitude weather conditions for aviation.

To bring back air samples, such a rocket might be fitted with a chamber timed automatically to open at a certain height, trap a small sample of air, and close again for the descent. It could carry also the standard instruments now used on small sounding balloons, which are sent up by the Weather Bureau to measure temperature and pressure and which never reach more than fifteen or twenty-mile altitudes. A "sun camera," combining a camera and a spectroscope, would be used to analyze the sun's light.

When Professor Goddard's new nine-foot rocket soared over Worcester, he himself was eagerly observing its flight. The last of its explosive used up, it turned earthward. A parachute opened and gently lowered to the ground the empty steel shell. Professor Goddard recovered this and found still intact a camera and a barometer that had been sent aloft.

"The height, though not great," Professor Goddard told POPULAR SCIENCE MONTHLY, "was sufficient to demonstrate clearly the satisfactory operation of the rocket. Such a device is capable of exploring the high atmosphere and even the regions beyond."

Working model of the Goddard rocket to explore high altitudes

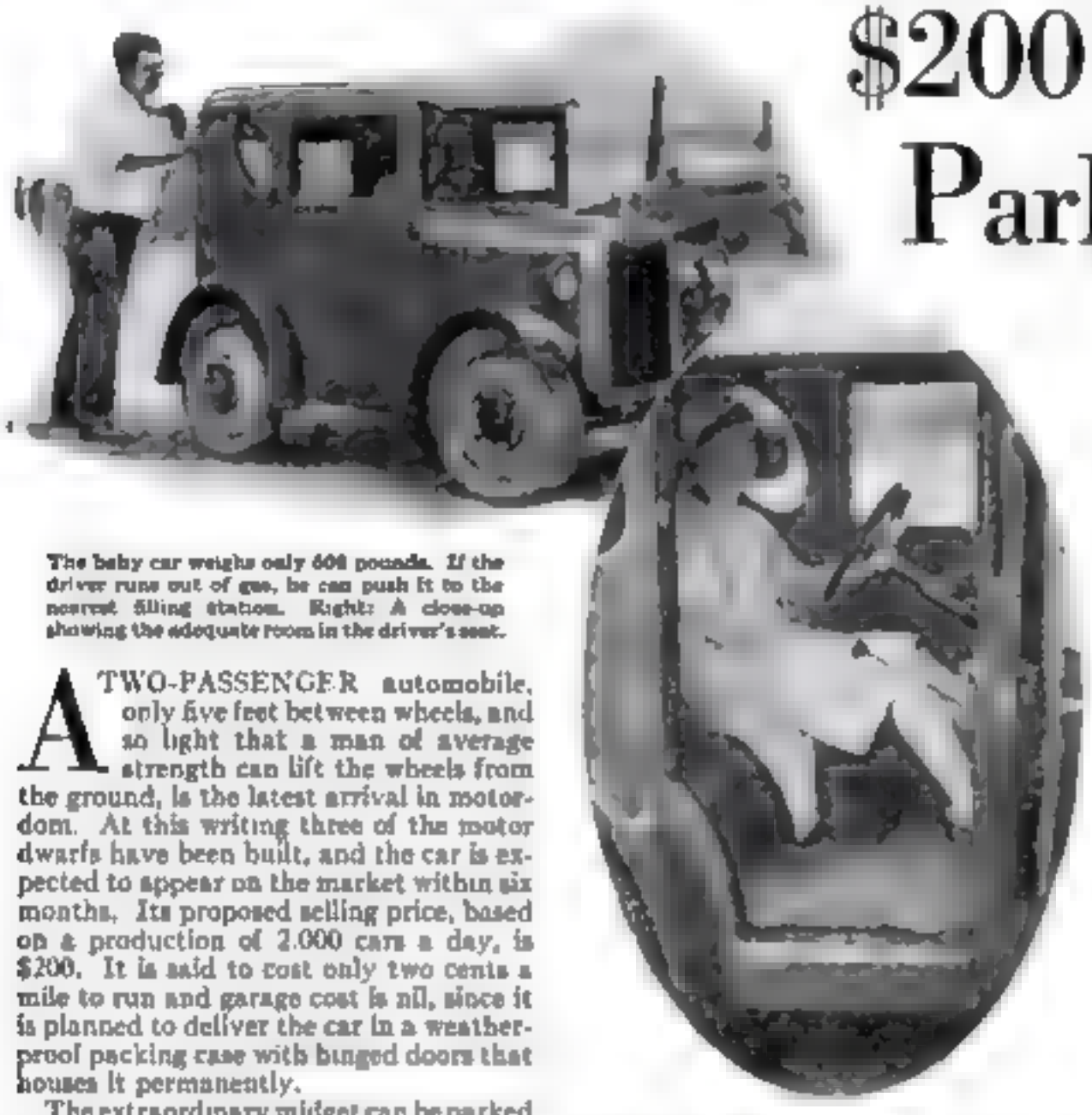
From this forty-foot steel tower on a farm near Worcester, Mass., Professor Goddard shot his new rocket. At the right is the shack where the rocket was fired electrically.

AS LONG ago as 1916 Professor Goddard proposed his scheme to reach great altitudes. He enlisted the aid of the Smithsonian Institution in his research, which was also watched with interest by the American Association for the Advancement of Science and by the United States Government. In the years of work that followed he destroyed several unsatisfactory models before he arrived at a practical device. The first Goddard rocket, patented during the war, contained multiple charges to be fired one after another. After laboratory tests this design was modified. In the new design the explosion is continuous.

In the course of his experiments there have been persistent reports that Goddard planned to shoot a rocket to the moon, where its arrival was to be marked by the explosion of a heavy charge of flashlight powder visible through powerful telescopes. Professor Goddard never has denied that his invention might prove adaptable to such a venture, but his present plans are much more practicable. It is said, however, that, with a sufficient charge of explosive, one of his projectiles might even escape from the earth's restraining gravity and become a man-made meteor in outer space.

$200 Midget Car Parks in a Box

New Toy-Sized Auto with 60-Mile Speed May Be Sold by Mail



The baby car weighs only 600 pounds. If the driver runs out of gas, he can push it to the nearest filling station. Right: A close-up showing the adequate room in the driver's seat.

A TWO-PASSENGER automobile, only five feet between wheels, and so light that a man of average strength can lift the wheels from the ground, is the latest arrival in motordom. At this writing three of the motor dwarfs have been built, and the car is expected to appear on the market within six months. Its proposed selling price, based on a production of 2,000 cars a day, is $200. It is said to cost only two cents a mile to run and garage cost is nil, since it is planned to deliver the car in a weatherproof packing case with hinged doors that houses it permanently.

The extraordinary midget can be parked in half the space required by an ordinary car. It turns completely around without crossing the center line of the average road. Being a foot less in width than the standard automobile, it can sneak in and out of traffic jams. On the open road a speed of more than sixty miles an hour is claimed for it

The new car is a midget even by comparison with the small cars that are common in Europe. Its sixty-inch wheelbase is the shortest ever. The smallest American car now in production has a wheelbase of 103½ inches. The new car weighs only 600 pounds, and is said to run fifty miles on a gallon of gasoline.

Radical departures from conventional design make the toy-sized car so light that it may be rolled about with one hand. It has neither chassis nor springs. There are no axles, in the usual sense of the word. Each wheel is independently attached to the underside of the body. The car has just half the usual number of parts for a conventional automobile.

The inventor is James V. Martin, an airplane manufacturer of Garden City, N. Y. His knowledge of plane construction helped to dispense with heavy springs which are standard on other cars. Instead of springs, each wheel is supported by a coil of "aviator cord," which absorbs shocks in airplane wheels. With a core of rubber strands and a protecting web of fabric, this cord is designed to last for 25,000 miles of driving, after which it may be replaced inexpensively.

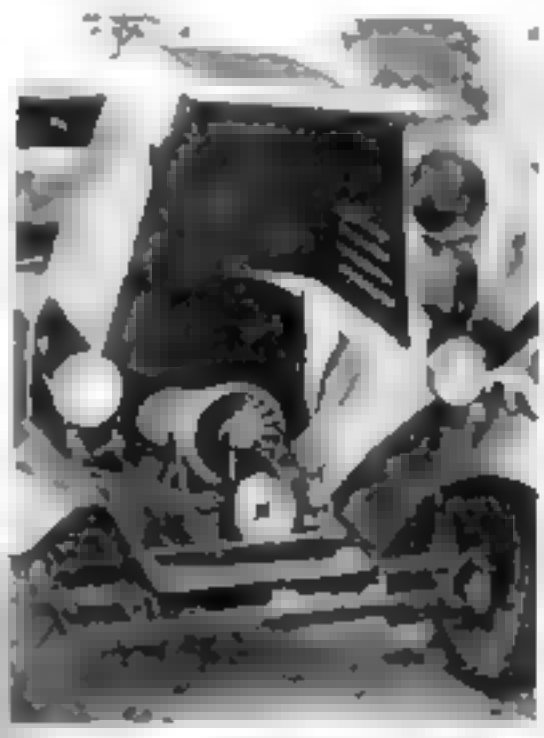
POWER reaches the rear wheels through a diminutive differential gearbox attached rigidly to the body. Light shafts drive the rear wheels through fabric universal joints. These enable the wheels to roll comfortably over inequalities in the road. The front wheels swing wide for easy steering. The shaft through which they support the front of the car does not bounce up and down with the wheels, as it would if springs were used. This minimizes "unsprung weight," that tire-punishing load that is not supported on springs.

Despite its small size, the four-cylinder, air-cooled motor that drives the car is said to develop twenty horsepower. Its unique cooling system consists of a jacket completely inclosing the motor, and through which a fan forces a blast of cooling air. The "radiator," which is simply an ornamental dummy since no water is used for cooling, lifts up with hood to give access to motor.

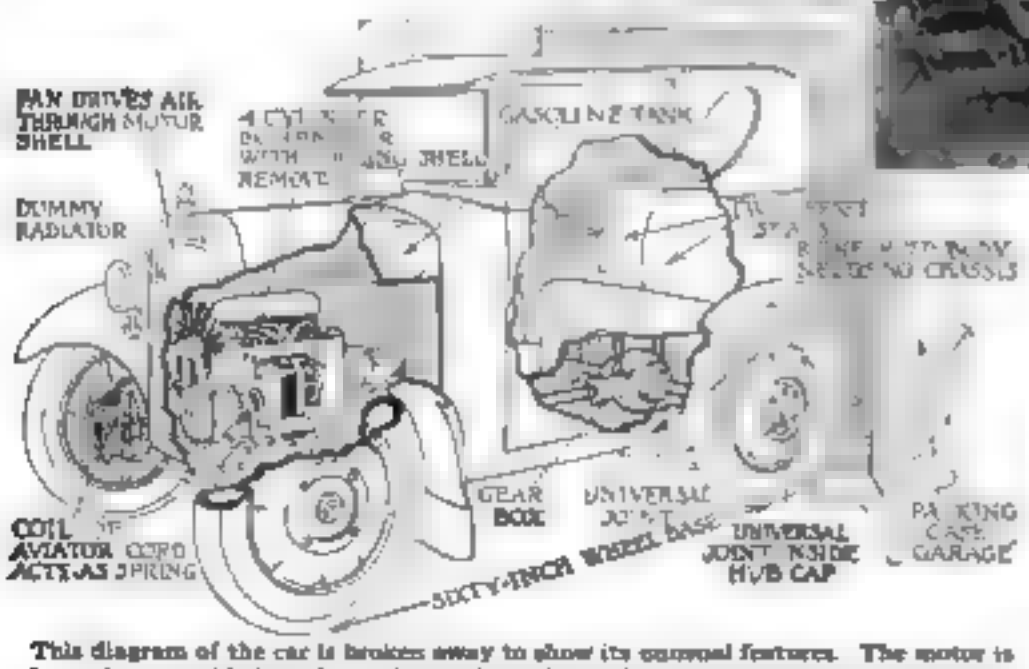
Gear shift and other controls are standard. An electric starter now used may be replaced in future models by a "kick" starter like a motorcycle's that can be operated from the driver's seat.

Besides the two-passenger closed model, the inventor has completed designs for a four-passenger pleasure car and a half-ton commercial truck of the same short wheelbase, the latter to weigh only 700 pounds. A large mail-order house is reported to be considering selling the new models by mail.

How a coil of "aviator cord" acts as springs.

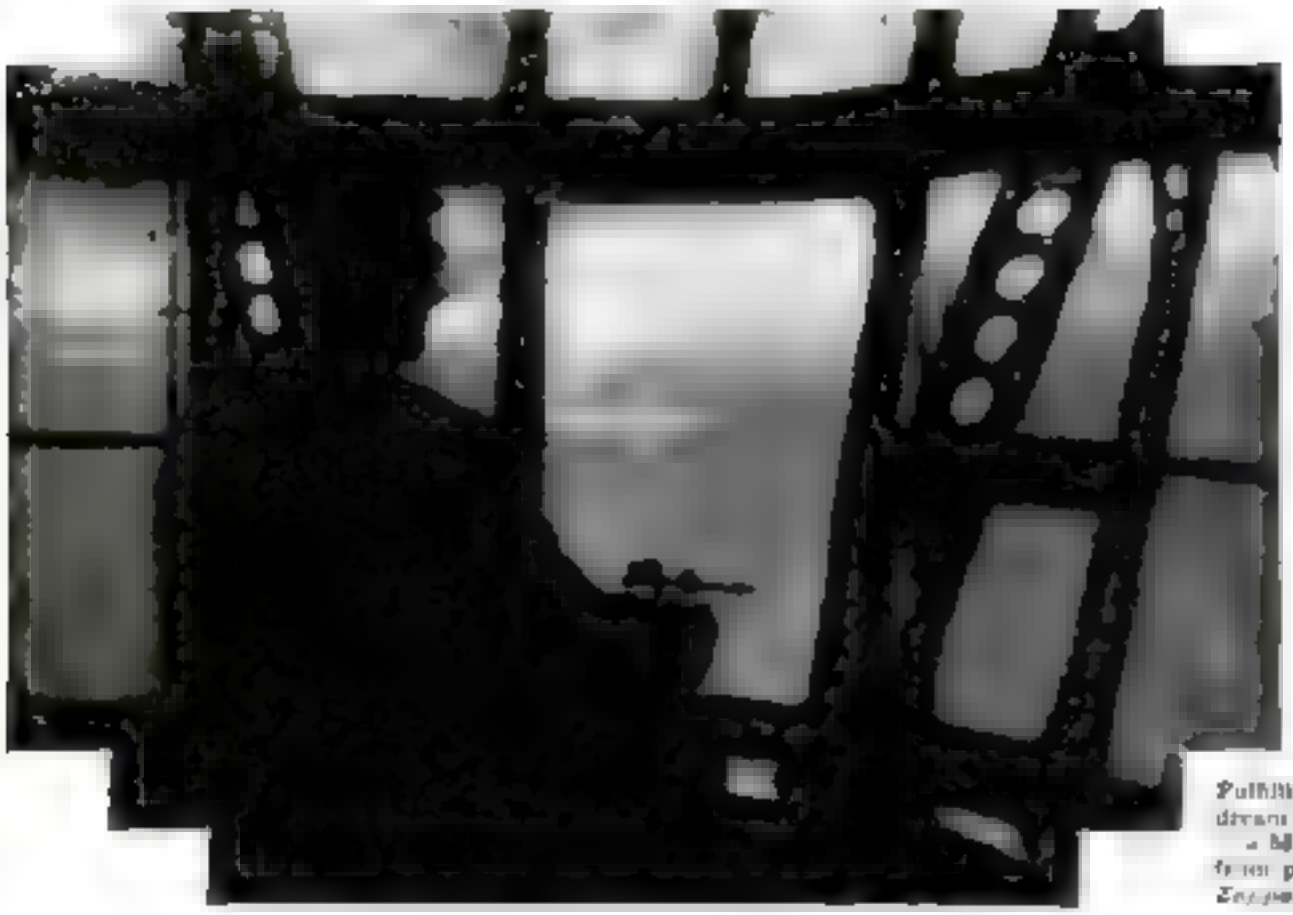


Hood with dummy radiator lifted to reveal four cylinder air-cooled motor.



This diagram of the car is broken away to show its unusual features. The motor is housed in an odd-shaped ventilator through which a fan forces a blast of cool air.

A close-up view of "aviator cord," a cable consisting of dozens of rubber bands.



Pulsating Count Zeppelin's dream of trans-ocean airships — Mid Atlantic sunset view from quiet bower of the *Graf Zeppelin*, America - bound.

The Zeppelin Grows Up

From a Cranky, Motorized Balloon to Gigantic Ocean Airliners—The Story of Count Zeppelin and His Long Struggle to Perfect the Dirigible

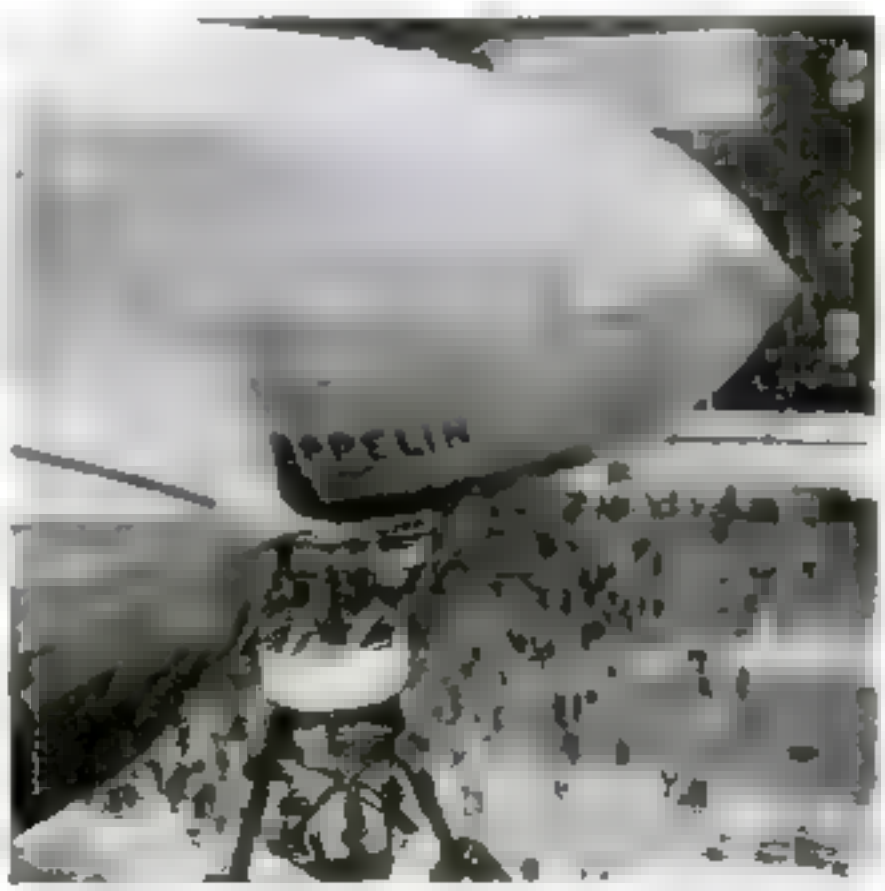
By WALTER E. BURTON

TWO airships of size greater than any ever built are soon to go under construction at Akron, O., for the United States Navy. Two other American ships of the same 6,500,000 cubic feet gas capacity, are being designed for commercial service over the Pacific between California and Hawaii, while a project is reported under way for a regular transatlantic dirigible service. Each of the two new commercial ships will accommodate eighty passengers; and, as in the Navy ships, will inclose passenger compartments and motors within the hull—a novel departure in design made possible by the use of non-inflammable helium gas for lifting.

Other innovations distinguish the new English air leviathans *R 100* and *R 101*, one of which uses girders of stainless steel instead of the hard aluminum alloy, duralumin.

These new airships, and the flying exploits of the *Graf Zeppelin*, which at this writing was attempting the first airship voyage around the world, form the latest chapter in the story of the rigid airship's development—the story of the Zeppelins and of Count Zeppelin, their builder.

On a July evening in 1900—three years before the airplane had been invented—a 420-foot airship shaped like a huge lead pencil was towed by a group of men out of its floating hangar on Lake Constance, on the German-Swiss border. At the ends of restraining ropes it ascended to a height of seventy-five feet. Then the ropes were cut and two sixteen-horsepower motors on the airship started.



The *Graf Zeppelin* just before starting her round the world cruise, moored alongside the *Los Angeles* in foreground in the Navy hangar at Lakehurst, N. J. Both are products of Count Zeppelin's genius.

This ship, the *LZ 1* (L.Z. is an abbreviation of Luftschiff Zeppelin—German for Zeppelin Airship) was the first Zeppelin. First it nosed down a little. Then the propellers took hold and it sailed gracefully upward. A few moments later it began to behave strangely. First it would advance a few hundred feet. Then, for no apparent reason, it would reverse and back up an equal distance. Failure of a sliding weight that balanced the craft had put the steering apparatus out of commission. But those on the ground did not know it. Aboard the cranky craft its inventor, Count Zeppelin, managed to land it safely with its four other passengers.

THUS was fulfilled, if in somewhat erratic fashion, the inventor's dream of many years. The adventurous Count Ferdinand von Zeppelin, born in 1838 on the German shores of Lake Constance, long had held the vision of great airships for com-

mercial and military operations. It was in America that his idea took definite form.

After graduation from a military school at Ludwigsburg, he had become a lieutenant in the Württemberg army. But the quiet life of a peace-time garrison did not appeal to him. At that time the Civil War in America beckoned to adventurous spirits the world over, and Zeppelin found it an excuse to "add to his military education." He came to the United States and joined the Union Army as a volunteer officer. By chance he was assigned to a balloon corps. At St. Paul, Minn., he made his first balloon ascension, followed by many more in the weeks that ensued.

THEN the idea came to him that a power-driven balloon capable of being steered would be a valuable invention—an impression heightened by his hunting parties with other officers, in their free time, through sparsely inhabited regions of the Mississippi Valley. A dirigible—"steerable"—balloon, he became convinced, would prove a boon for reaching inaccessible, unexplored places of the earth.

It was a long time, however, before his half formed ideas took definite shape. Meanwhile he served in the Franco-Prussian war, saw balloons carry messages from besieged Paris, and perfected his own plans for a self-propelled balloon. By 1873 he had completed a design, on paper, for a dirigible—a design that, with later improvements, was the basis of the *LZ-1*, the world's first successful rigid airship.

PERHAPS no single machine of modern science has demanded of an inventor more optimism and faith than the rigid airship. In a branch of engineering that requires some of the most intricate of all mathematical calculations, Count von Zeppelin had no precedent to go by. The wonder is that he produced a ship that would fly at all. And it is not surprising that the King of Württemberg, to whom Zeppelin appealed for aid to build his first machine in 1887, failed to proffer assistance.

With no experimental data, nothing but his own imagination to draw upon, Zeppelin perfected his plans. He foresaw that an airship, to carry freight and passengers to distant ports, must be a huge craft. In such a ship it would be foolish to trust the valuable lifting gas to a single compartment. So Zeppelin worked out the multiple-cell principle. He put the gas in a number of separate compartments. One or more could be destroyed, and the gas lost, without causing the ship to fall. Moreover, cross-partitions that separated the gas chambers would keep gas from surging from one end of the ship to the other and would improve her stability. Another revolutionary idea was the introduction of a rigid framework of light metal girders, covered with cloth.

To develop these plans Zeppelin, by that time an army general, resigned his military post. He enlisted the aid of an engineer named Kober and added the finishing touches to the main principles he had already laid down. In 1894 Zeppelin submitted the plans to a special committee of leading German scientists. The group failed to recommend the building of the airship—though it could find no flaw in the specifications.

Now a man passing middle age, fighting to make his invention come true, Count Zeppelin at sixty succeeded in obtaining support to build his first ship. And then an unforeseen event almost ruined his plans. Another group of experimenters had built, near Berlin, a rigid airship about 150 feet long, of essentially different design, and covered with metal. Unlike all previous "rigid" airships it succeeded in getting off the ground. But on its first trial flight it made a forced landing and was completely wrecked. The framework was too weak. Only after great difficulty did Zeppelin convince his supporters that this was not a fault inherent with all rigid airships.

The late Count Ferdinand von Zeppelin, creator of dirigibles. During America's Civil War he served as a balloon corps officer in the Union Army.

A machine of the *Graf Zeppelin* climbing out of a motor gondola to repair a damaged oil tank.

TO HOUSE his first creation, Zeppelin built, on the shores of Lake Constance, a structure unlike any other in the world—a shed that floated on the water. It was a huge building even by modern standards, 450 feet long, with eleven windows at each side to admit light to the great single room where the Zeppelin was to be built. It floated on ninety-five pontoons, some of which supported an ingenious detachable floor. This floor when unhitched from the rest of the hangar and floated out in the lake, was to serve as a launching platform for the dirigible. The shed was anchored at one end so that it could swing in the wind, keeping the mouth always on the leeward side to facilitate handling the airship. After this structure was built, it narrowly missed disaster several times, when heavy winds tore it from its moorings and threatened to dash it on the shore. From naval dockyards at Kiel, Zeppelin obtained a number of huge ship's anchors, and at last he was ready to build his airship.

Under direction of Zeppelin's builder, Herr Kaubler, seventy carpenters and

The *Graf Zeppelin* sailing over New York City's skyscrapers after arrival from Germany on her first trans-atlantic flight. Photographed from an airplane.

An old photo showing Count Zeppelin ringing a ship's bell to signal his crew during ground maneuvering of his *LZ 4* in 1908. Note the odd construction of this early Zeppelin's car

The *LZ-2* Count Zeppelin's second airship, on its floating platform in 1906. It was 420 feet long.

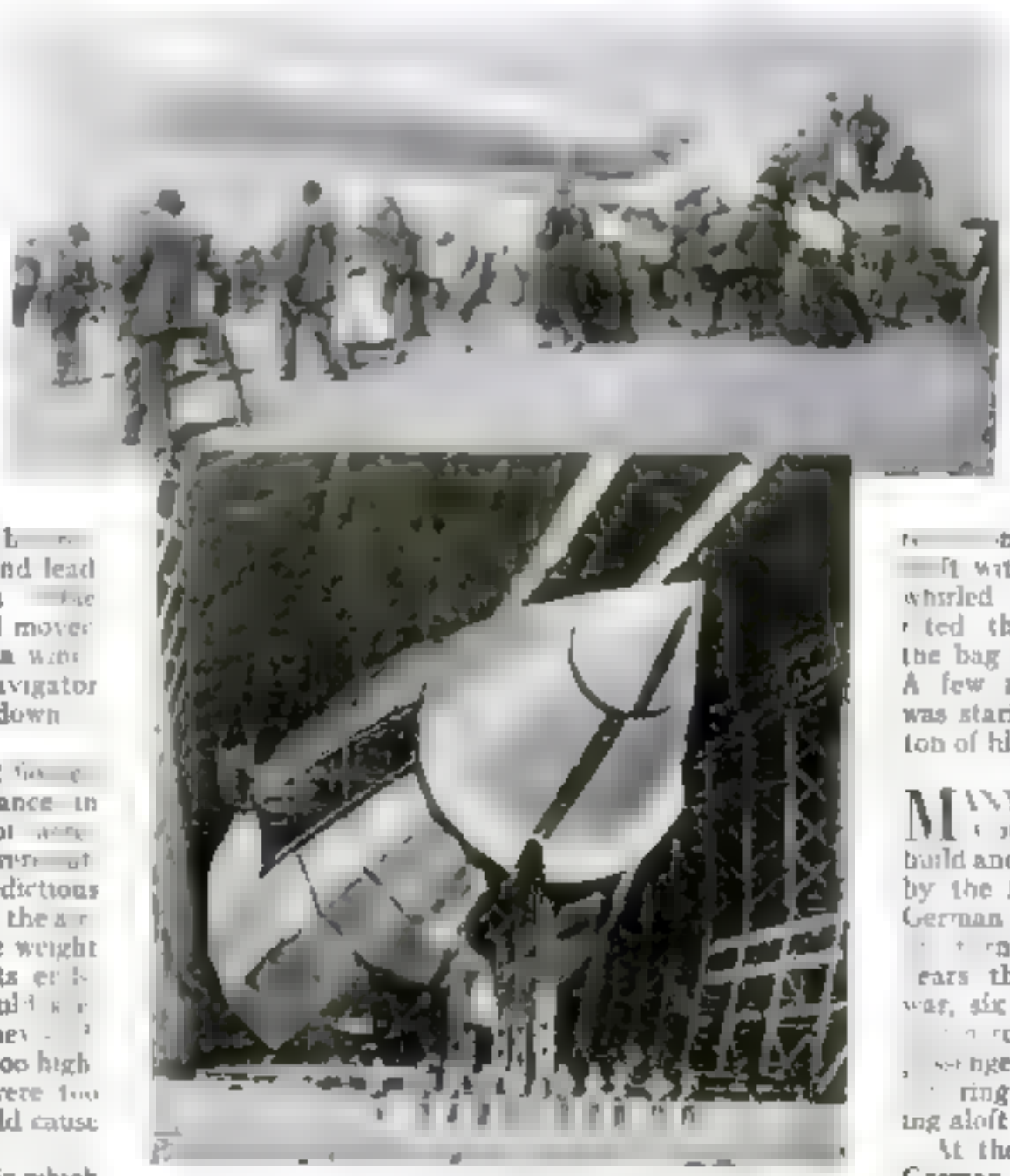
thirty mechanics fitted seventeen individual gas cells, holding in all about 389,000 cubic feet of hydrogen gas, into the 420-foot long framework. Aluminum rods ran from one end to the other to form this framework, braced by many-sided "rings" set eight yards apart. Held rigid by innumerable cross wires, they looked like a row of great bicycle wheels. A light network of ramie, a vegetable fiber, covered the frame members. Between each pair of rings was placed one of the hydrogen gas bags of rubberized silk cloth, each capable of holding a gas supply for two or three weeks. Outside the aluminum framework, a skin of cotton cloth protected the valuable gas in the cells from sun and rain. Each filling of the ship cost about $2,500 and took fully five hours.

Two tiny sixteen-horsepower motors—each less powerful than those which run the smallest American automobile today—drove the aluminum propellers of the big ship. Their diminutive five-foot gondolas fore and aft, connected by a catwalk, were swung far enough below the hull to minimize fire danger. Sufficient fuel could be carried for ten hours of flight. A novel feature, already mentioned, was the balancing apparatus—a 660-pound lead weight attached by a cable between the two cars and moved forward or backward by a windlass. Thus the ship's navigator could tilt the nose up or down.

One of the early Zeppelins rising from Lake Constance. Below it are the floating hangar in which it was built, and launching platform.

THIS was the ship that [illegible] out on Lake Constance in 1900, before the eyes of [illegible] nautical experts. Critics were not spoken in their doleful predictions of mishap. They declared the airship would bend with the weight of the gondolas under its ends. They feared the ship would turn over in mid-air because, they said, its center of gravity was too high. Some said the motors were too close to the hull and would cause an explosion.

But the first test flight, in which the ship flew at a speed of more than thirteen miles an hour, proved these fears groundless. Later it made two short, successful flights, and was then dismantled because it cost too much to run. But it had proved that Zeppelin's dream was practical.



Rear of the huge new British dirigible *R-100* in its hangar. Above: Crowds watching a flight of the *LZ-4* in June, 1909.

IN HIS early ventures, Zeppelin was handicapped by lack of reliable motors. In 1905 he built the *LZ-3*, with two eighty-five-horsepower engines. It made a forced landing in a field and a storm tore it to pieces before it could be repaired. Zeppelin built a third ship almost exactly like it, but with stabilizers added to the stern. It developed a speed of twenty-nine miles an hour. The German Government became interested and commissioned him to build a larger ship, the ill-fated *LZ-4*, with 100-horsepower motors. Zeppelin flew it over the Swiss Alps to Lucerne and back again on July 1, 1908, attracting world attention. This triumph he proposed to follow with a trip down the Rhine Valley. But another storm caused another forced landing—and this time the ship was [illegible]m its moorings and sailed [illegible]ft with no one aboard. As it whirled skyward, something ignited the hydrogen. Instantly the bag was enveloped in flame. A few moments later Zeppelin was staring at the twisted skeleton of his latest efforts.

MANY thought then that Count Zeppelin would never build another dirigible. But, aided by the financial support of the German people, he had reached [illegible]rn of his fortunes. In the years that followed, before the war, six of his dirigibles, put in [illegible]mercial service, carried 37,200 passengers safely on 1,600 flights, covering 90,000 miles and remaining aloft a total of 3,200 hours.

At the outset of the war, the German Government commandeered all (Continued on page 102)

Plant "Pills" Grow Bumper Crops

How root development, at the expense of the plant, is halted by the new method. 1. Narcissus grown in water with "pills"; 2, in water with commercial fertilizer; 3, in water only.

NOT since the death of Luther Burbank, the great plant wizard, has there been a discovery of such apparently revolutionary importance to the farmer and back-yard gardener as that which Mr. Dunn describes here. Fields of grain and vegetables flourishing on the desert; summer flowers blooming at Christmas; five-inch pansies and double-sized potatoes—these are a few of the marvels of a new scientific agriculture which replaces arid soil with shallow tanks of water fertilized by the introduction of life-giving chemicals.

By

H. H. DUNN

EMANCIPATION of farmers and growers of fruits and flowers from the vagaries of soil, season, and climate is promised by a discovery, of revolutionary importance in crop production, announced by the department of plant physiology of the University of California. Through the use of a chemical "plant pill," administered to plants grown in shallow tanks of water, cereal and vegetable crops now are made to thrive under desert conditions of heat, arid soil, and lack of humidity. Fruits and the fruitlike vegetables are brought to ripening ahead of normal time, and flowers of numerous varieties, usually blooming only in midsummer, are provided for Christmas and New Year's.

Production of wheat, barley, rice, and cotton is increased from twenty-five to fifty percent. Beets, carrots, turnips, and other root crops are speeded to full development twenty to thirty days ahead of normal, their size augmented by sixty percent, without loss of tenderness. Tomatoes, grown by the new method alongside those cared for in the standard manner, show quantity increases of as high as forty percent, with larger and heavier fruits. Berries are made to ripen early, and the size and number of the fruits that they produce nearly doubled.

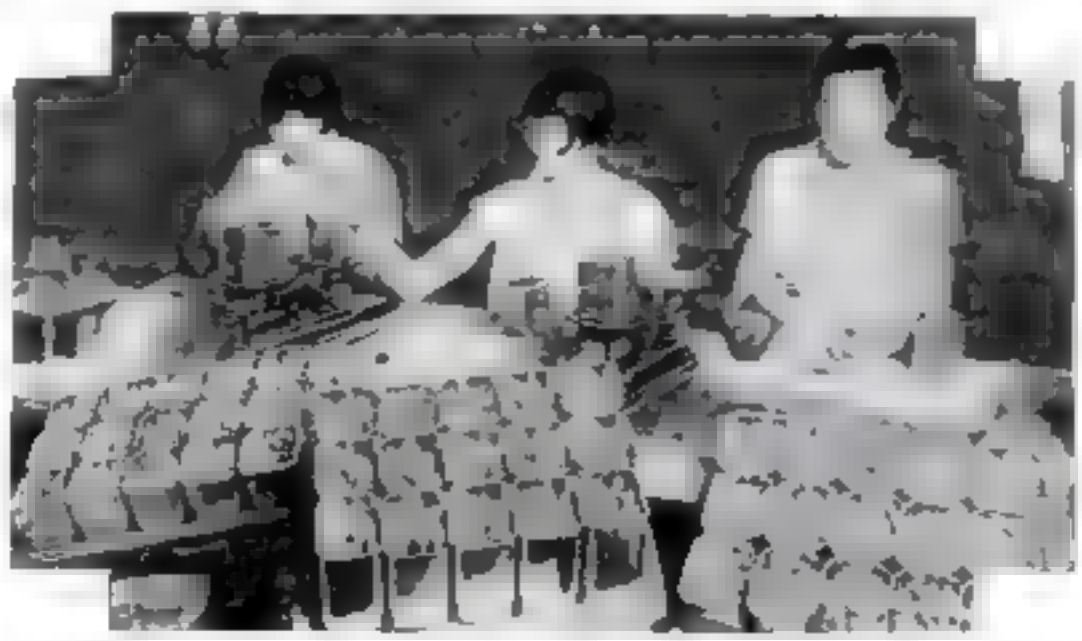
Full blown roses are produced in sixty-five to eighty days in normal house temperature in midwinter. Pansies four and five inches in diameter are common. Sweet peas five feet high and laden with blossoms are brought to bloom from the seed in sixty to seventy days, and in some instances much less. Dahlias are made to blossom in two months in standard home temperatures, with the mercury at freezing outside. Other common garden flowers are made to provide flowers in winter as readily as in the summer.

Fully five thousand experiments over a period of five years have resulted in this discovery, which Dr. W. F. Gericke, head of the department of plant physiology, calls "the greatest gift to agriculture since the science of fertilization of soils was worked out." In this opinion he is supported by the College of Agriculture at the University, and by scores of plant and soil experts, graduate students, and commercial florists, who have contributed to the experiments under Dr. Gericke's direction.

Planted in October, these sweet peas grown by the plant pill process blossomed in December and January. Though raised out of their usual season, the vines grew more than five feet tall.

In brief, the secret of this new method of speeding plant development consists in administering combination doses of the seven elements of plant food, in the exact quantity and quality required by each different form of vegetable growth. These elements, combined in capsules, are introduced and dissolved in the soil or water where the plants are to grow. Bound together in a short tube, or cylinder, by means of a composition somewhat similar to plaster of Paris, the chemical combination contains nitrogen, phosphorous, magnesia, iron, potassium, and sulphur, the binding composition supplying the necessary calcium. In early experiments, an oval form of the "plant pill" was used, but later tests showed that the cylindrical form dissolves more equably and distributes its contents more evenly.

IN the long series of experiments which led to the discovery, it was found that each variety of tree, cereal, vegetable, or flowering plant demands a different coördination of some or all of the seven elements mentioned above. Further investigations determined the exact composition best adapted to the development of each. The composition which would produce sturdy sweet pea vines and abundant blossoms, for



Twelve stalks of treated asparagus fill each of the standard cans at the center. The same sized cans shown at the left and right hold 24 to 36 stalks of untreated varieties.

example, had no similar effect on roses, or on pansies. Experiments with young plants and cuttings, however, revealed that the chemical combinations could be cut down to about a score, each one being best adapted to a certain group of plants.

THE discovery then was applied to commercial flower growing, without profit, but merely to learn if flowers could be speeded up in such quantities as to make them commercially valuable. Roses, pansies, sweet peas, dahlias, and other flowers were so produced in quantities during December and January, 1928–29, by florists working under Dr. Gericke's direction. Cost of this midwinter production of summer flowers was no greater than production by ordinary methods in the warmer season.

Although the "plant pill" has been applied successfully in soil, the best medium of growth is water, about one quart to each plant. Rose cuttings, recently rooted and placed in water with the proper combination of fertilizing elements, doubled in size and presented quantities of full-blown flowers, of large size, in eighty-five to ninety days. Sweet peas grew from seed and blossomed in sixty days and less. Dahlias, from seed, developed tubers, plants, and blossoms, in ninety to one hundred and ten days.

Hundreds of other experiments, of far greater economic importance, were carried on with cereal and vegetable crops, and with fruit-bearing shrubs and trees. Remarkable success has been met with in the cereal and vegetable fields. The [illegible] of asparagus stalks was increased [illegible] 100 percent, without impairing [illegible] or decreasing the number of stalks [illegible] hill. Potatoes were increased [illegible] half, without enlarging the [illegible] or altering the average number of tubers to the hill. Yield of tomato fields was increased by forty percent, with no addition to the size of the vines, or the area occupied by each.

Some of the largest potatoes ever produced, grown with the plant pill in otherwise unfertilized fields. Right: A cake of the pill material for use on a large scale

THIS crop development was in soil. Further experiments, during the last summer, however, showed decisively that if the food plants were grown in water, instead of earth, the rate of growth was more than doubled, the size of each [illegible] increased, and many more of [illegible] could be grown on the same area. Experiments with wheat, cotton, tobacco, and cabbage showed the same result. Cotton was brought to bearing of full bolls in ninety days. Wheat grown in water with the plant pill made twice the growth of the same variety in water with the best commercial fertilizer, and more than fifty percent greater growth than when planted in soil with the plant pill solution.

From these results, Dr. Gericke and his assistants, with the backing of the University of California, started experiments with tank production of food crops to determine costs of such production on a commercial scale. It was found that tanks six to eight inches deep were best adapted to the growing of all vegetables and cereals in the solution. At first tanks or trays about twenty feet long by five feet wide, made of wood and lined with tarred paper, were used. The paper was brought out and over to form a cover for the tank. In this top, small holes were punched close together. The seedlings were set out in these apertures, with their roots reaching the water in which had been suspended a number of the "pills."

In this manner it was [illegible] that 150 to 200 [illegible] more vegetables [illegible] be grown in a

Left to right: Wheat growing in commercial fertilizer in water; in water with plant pills, and in rich earth mixed with pill solution. Above: Roses in bloom after growing for two and one half months in tanks.

given area than by the present method of planting in soil, while as has been said, the size and rapidity of growth were increased [illegible]. All root crops, such as carrots, turnips, beets, radishes, sugar beets, and parsnips, showed the same increase in size and number. With "head crops," such as cabbage, cauliflower, celery, and lettuce, the number of plants could not be increased [illegible], but the rapidity of growth and size of each plant showed large gain over those planted in soil, or in water without the composition.

CONTINUED experiments along these economic lines, however, led to the conclusion that the shallow concrete tank, covered with tarred paper, or with heavily galvanized wire netting of small mesh, over which loosely woven burlap is laid, forms the best medium for the commercial production of vegetables and cereals. The separate jar, or the paper-lined, wooden tank, are considered best for the home or commercial growing of flowering plants.

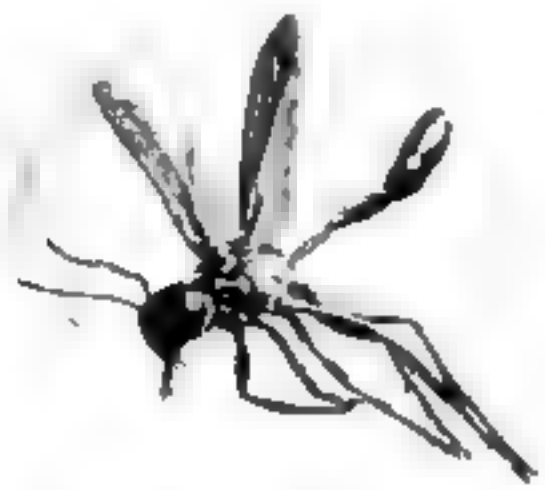
Going into costs, Dr. Gericke and his associates found that an acre of level land can be covered with concrete tankage, six to eight inches deep, divided into sections and laid flat on the surface of the earth, for a maximum of $250 in any part of the United States, where materials are expensive and labor costly. In other parts of the world, it is believed that the same coverage can be made at $150 to $175 an acre. In tracts of five acres or more, such as the average commercial vegetable garden, cost of tank construction in this country can be reduced to about $200 an acre. Thus, the tankage to cover a five-acre field would cost $1,000, or about three times the expenditure [illegible] to place that tract in good condition for vegetable growing each year.

BUT once the tankage has been constructed, it is a permanent improvement, with a life of about fifty years. No cultivation, irrigation, thinning, or weeding is necessary, beyond filling the tank with water and pacing the new composition in it. With the rapid growth of vegetables and cereals, as demonstrated at the University of California, about twice as many crops can be grown as now. This speed of growth tends to shut out insect pests, as does also the separation of plants from soil, whence come

(Continued on page 150)

The Bulldog of the Insect World

By E. BADE



A digger wasp in full flight—a terror to insects a dozen times its size. Note the threadlike waist and transparent wings.

A STRANGE "insect zoo" was established recently in England. The government experts in charge of it spend their time caring for armies of little six-legged soldiers—insects that prey upon other insects destructive to growing crops. These fighters are being shipped to different parts of the Empire to aid the farmers.

In California, a similar experiment is going on. Dr. Stanley E. Flanders, of the University of California, is breeding billions of gnat-sized members of the wasp family which lay their eggs within the larger eggs of other insects, particularly those of harmful moths. The wasp larva, after it hatches, grows within the egg, destroying the moth that was to emerge. In answer to a rush order, not long ago, Dr. Flanders sent 100,000 of the microscopic wasp eggs across the continent by air mail. They made the journey in a small tin can.

Among the enemies of injurious farm pests is the most dauntless battler of the insect world, a steel-blue and orange bullet on wings called the digger wasp. It will attack other insects a dozen times its size, and even makes a fearless onslaught upon the tarantula, the great venomous spider of the Southwest, thereby earning the name of "tarantula hawk."

This inch-long wasp with threadlike waist and orange band is a real friend of man, for the chief objects of its attack are destructive caterpillars of the cutworm variety. J. J. Ward, the English entomologist, reports that in one section of Devonshire, he found thousands of digger wasp burrows without discovering a single caterpillar in them, indicating that the wasps, during the previous year, had almost exterminated the caterpillars.

IT IS near the mouth of these burrows that the wasp engages in its dramatic conflicts. The female digs the burrow and does the hunting. On a hot July day, she begins work. Nervous, transparent wings aquiver, she alights on a dry bank or roadside. Digging like a dog with her front legs, she grabs up little chunks of dirt between her mandibles, then jerks her head sidewise to toss the small pellets out of the way.

Sometimes, it requires a day to burrow three inches into the wellpacked earth and hollow out a chamber about an inch across at the bottom. When the work is done, the wasp searches for a stone just the size to plug the mouth of the hole. She may spend an hour bringing and discarding stones before finding one that fits. The tunnel plugged, the huntress seeks her prey.

At the sound of her approach the caterpillar struggles to resist the attack. It rolls and unrolls itself, throwing its body about frantically. But the wasp, swooping down like a hawk, straddles her victim, grasping it by the neck with her mandibles. Rearing high on her legs, she lifts the front end of the worm from the ground and with strange instinctive knowledge of anatomy, curves the end of her abdomen down, plunging a poisonous stinger between two segments near the central nerve cord. Instantly the caterpillar relaxes, paralyzed. The hypodermic needle of the stinger punctures half a dozen other places to insure that the victim will remain alive, though unable to move, for a week or more.

BEFORE dragging the caterpillar to the burrow, the wasp carefully turns it over on its back so that the legs will not offer added resistance in pulling it along the ground. At the entrance of the tunnel, she lays an egg on the side of the victim, before tugging it underground to form a living storehouse of food for the larvae. Later, a second caterpillar is added to increase the larder.

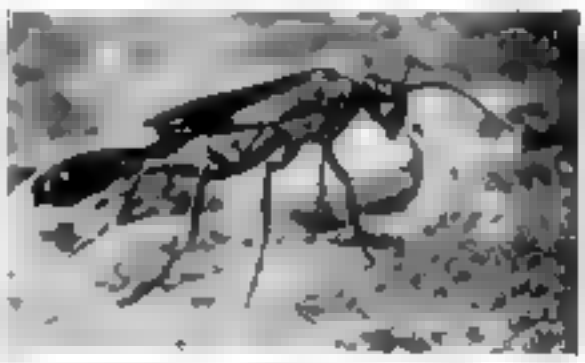
The mouth of the tunnel is then filled with dirt, which is pounded down by means of a stone hammer—a pebble held firmly between the mandibles. Sometimes, a bit of wood is used in place of a pebble, and once a wasp was seen hammering down the soil with the leg of a grasshopper.

Two or three days after the nest is sealed, the larva hatches out. It consumes the caterpillars and then spins a pale yellowish cocoon in which it rests until the following June, when it emerges as a wasp. Every fall, the parents are killed by the

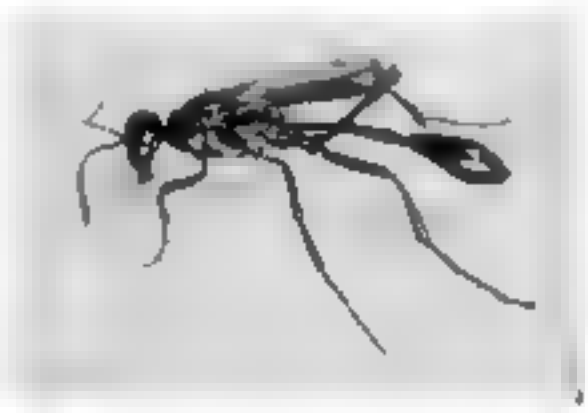
(*Continued on page 158*)

Swooping down like a hawk, the wasp begins her attack on a terrified caterpillar.

Astride the victim, she grasps it with her mandibles and drives home the stinger.



Imprisoning the victim in her burrow, she tamps the soil with a pebble held in her jaws.



The thread-waisted digger wasp at rest. The insect measures about one inch in length.

Preparing to drag a paralyzed caterpillar into the burrow to replenish the family larder.

The wasp lays her egg on the side of the victim. The larva hatches to find a ready meal.

This medallion is the official insignia of the Golden Jubilee commemorating the invention of the incandescent lamp by Thomas A. Edison fifty years ago.

Fifty Years of Flameless Light

The World Pays Tribute to Thomas A. Edison on the Golden Anniversary of the Incandescent Lamp, Which He First Made to Glow with a Bit of Thread

GOVERNMENTS and institutions throughout the world on October 21 will pay tribute to Thomas Alva Edison, the world's greatest inventor. That day marks the fiftieth anniversary of his invention of one of man's most important contributions to man—the practical incandescent electric lamp. In celebration of Light's Golden Jubilee, cities throughout the land will glow with colorful electrical displays. Impressive ceremonies have been prepared. A special postage stamp has been issued by the United States Government in honor of the genius who turned night into day.

It was just fifty years ago that the Wizard of Menlo Park, working in his tiny laboratory in New Jersey, took a bit of carbonized cotton thread, and introduced it into a globe where it glowed brightly for forty hours—a light without flame. This after many years of experimentation, during which he labored unceasingly toward the solution of a problem which many experts of the time considered so impracticable as to be classed almost with perpetual motion. That problem was the production of an electric lamp, economical and convenient enough to provide illumination in any home, shop, or office.

A FEW years before Edison began work on the subject, the carbon arc light had been introduced for street lighting. Edison's experiments early convinced him that this form of illumination would not be workable indoors. He saw that the only solution was an incandescent filament—one capable of high resistance to electric current, whose light might be turned on or off at will. At the outset he tried to carbonize paper for the filament between charged wires. The heat consumed it. Experiments with many other substances—even human hair—failed likewise. Meanwhile he was busy developing a glass bulb in which the filament might be made to glow in a near vacuum. Night and day he and his assistants labored in the laboratory, until the glowing bit of cotton thread rewarded them at last.

BUT with that first electric lamp, Edison's quest for the perfect incandescent light was by no means ended. For many years he experimented with every procurable fiber in search of one that would resist intense heat. Chance, combined with the great powers of observation and concentration which are among his most notable characteristics, assisted him in finding the fiber he sought. While fanning himself one hot day he observed the tough strip of bamboo running around the edge of the fan. Within an hour he had cut the strip, carbonized it, and introduced it into lamps. The result was what he desired. It gave an excellent light and, what was more important, proved satisfactorily durable.

In an effort to find the best kind of bamboo for this purpose, Edison instituted a world wide search for all varieties.

Edison's development of the incandescent electric light was accomplished in the face of many obstacles, not the least of which was ridicule from scientists and laymen. "It's the work of the devil!" said some cranks. Scientists laughed, affirming that such an application of electric current was doomed to failure.

But Edison never wavered. While others talked he worked. He met the opposition of arc light and gas companies by providing man with a better, safer, and more economical means of illumination. He went further. He overcame the mechanical difficulties which hindered the application of his new invention to a wider, more general scope. He invented a better dynamo than the world had ever before known. The central power plant then became a possibility that was swiftly realized.

The distribution of power for private consumption followed closely on the heels of the electric bulb and the dynamo. This resulted in the revolutionizing of industry. It brought about a new conception of industrial operation. It made it possible for many large industrial units to be operated from a central point, instead of every plant having its own engines and boilers.

Electrified railroads, subways, and street railway lines, as they are today, were made possible by the genius of Edison. And two-thirds of the homes in America are indebted to him for the convenience and enjoyment they derive from electrical equipment.

THE age of light is young. After fifty years we can only glimpse the possibilities of the future electrical age. Every year witnesses an appreciable increase in the total amount of energy generated. Last year the gross revenue from light and power totaled more than $2,000,000,000. In 1929 more than $700,000,000 of new capital will be spent for electrical expansion in the distributing field alone.

It is gratifying to the world to know that Edison is here to look over this span of fifty years and see with his own eyes the blessings that his genius has brought to mankind.

Light's Golden Jubilee will give mankind an opportunity to express its appreciation of Edison's gifts and to accord him a friendly tribute which will mean more now than bronze statues and marble slabs fifty years hence.

While Edison is still alive the youth of the world may catch a profoundly human inspiration. From him, who was so little appreciated in his youth, they may receive a practical lesson in success. He is a living inspiration—an example of what perseverance and industry can accomplish.

Thomas A. Edison—His Life Story Told in Pictures

THE picture at the right no doubt expresses better than any words the feelings of millions of Americans as the world celebrates the Golden Jubilee of electric light. What man would not like to shake the hand of Thomas A. Edison and to thank him in person for the scores of modern comforts and conveniences his inventions have made available everywhere?

The story of Edison always bears retelling. On the following pages the drama of his achievements is presented in pictures a fresh reminder of America's debt to this "kindly servant."

William H Meadowcroft Edison's right-hand man for forty-eight years, offers his congratulations.

The little brick house at Milan O where Thomas A. Edison was born on February 11 1847 and where he lived until he was seven years old His parents have moved to Port Huron Mich. In this house he had his first schooling from his mother

Edison's original drawings for the phonograph invented in 1877. The notes on his handwriting at left refer to preliminary experiments and conclusions. There is no doubt that I shall be able to store up and reproduce at will materially at any future time the human voice perfectly

Ed son at the age of three and one half years Townsfolk of Edison called him addled But early he showed signs of genius in boyish experiments in chemistry

This interesting contemporary print reproduced from Frank Leslie's Almanac for 1879 shows Edison standing at right with hand behind his back explaining the success of one of his first public exhibits of the phonograph in his laboratory at Menlo Park N J The machine became a public sensation

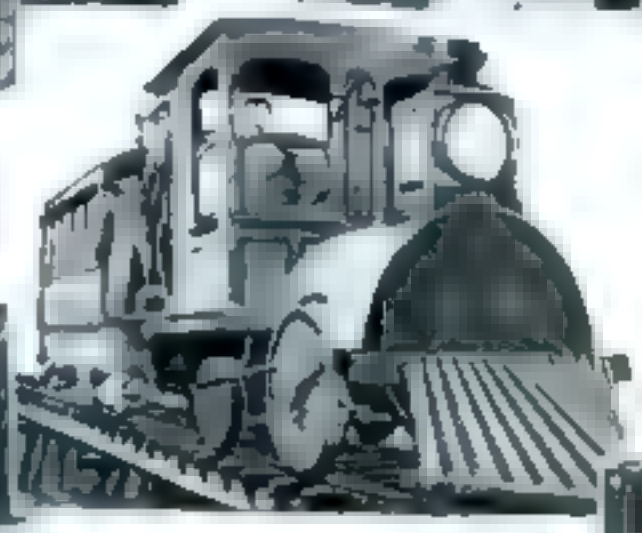
At the age of fifty two Edison was creator of new and great inventions One part of Edison's fame rests on the fact that at the time he invented the phonograph he was developing lamp Already he had invented many telegraph and telephone devices

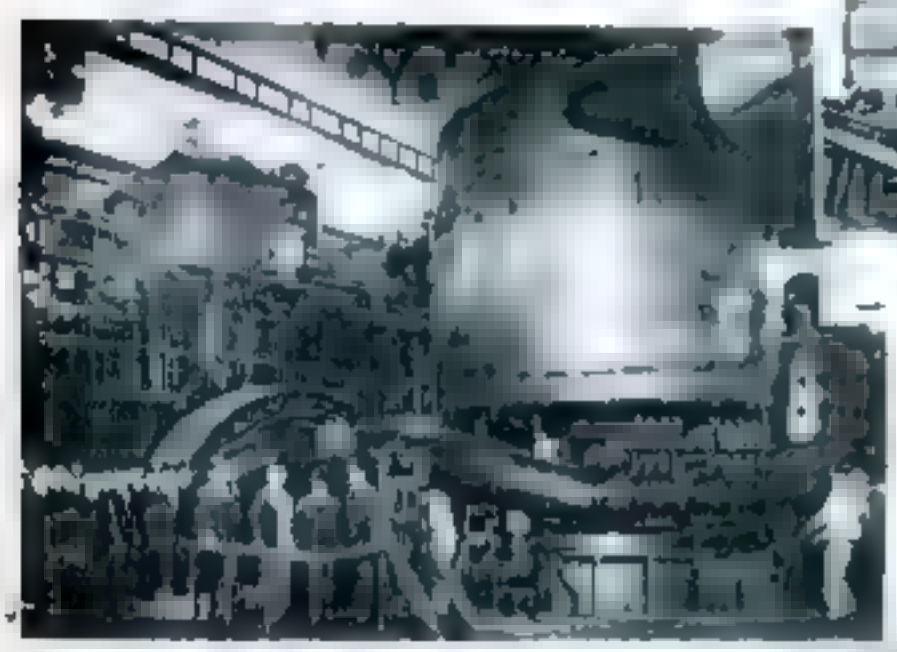
Another interesting print representing Edison and his assistants preparing one of his first incandescent lamps for its life test in the Menlo Park laboratory fifty years ago. The first successful lamp was lighted on October 21, 1879, and burned continuously for more than forty hours. Edison, standing with hand in pocket, is shown superintending the work of driving the traces of occluded gases from the carbonized cotton filament of his lamp with the current from an electric battery.

The Edison lamp works at Menlo Park in 1880. In this famous little frame building Edison tested thousands of substances to develop the ideal lamp filament. In the face of ridicule, he gave the world a new and better form of light and by inventions in electrical machinery, he began the revolution of industry.

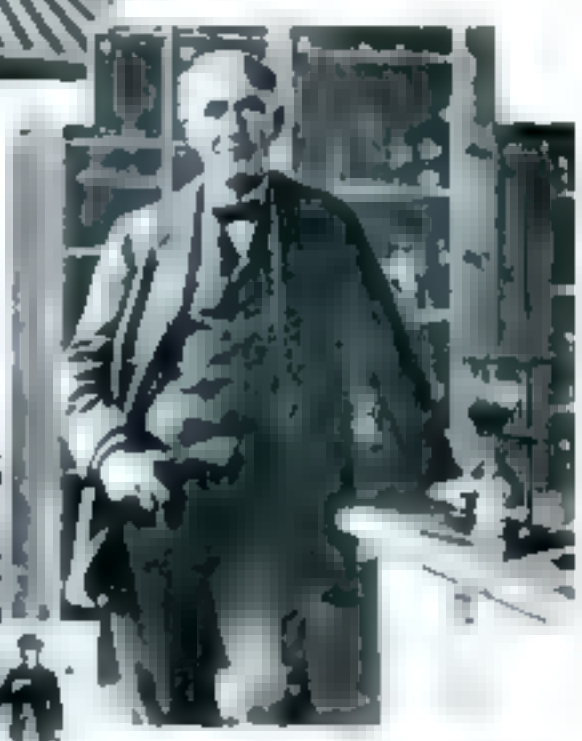
The first Edison electric railway at Menlo Park in 1880 with Charles Batchelor at the throttle. On a trial run the train was ditched at a curve on the one third mile track while speeding forty miles an hour "A beautiful experiment," said Edison.

A contemporary picture portraying Edison, the young telegrapher at work on one of his hundreds of experiments that made possible the transmission of multiple telegraph messages over a single wire.





This curious old photograph shows Edison in the cab of his electric railway locomotive developed at Menlo Park in 1883. Railroad engineers at first called his system of electric operation impractical. Yet today the same basic principle is employed with, of course, many elaborations by great American railroads.



Eighteen years ago this 30,000 horsepower turbo-generator of the New York Edison Company was the world's largest. The newest will develop 210,000

At right: Interior of first Edison central lighting station in New York City, 1882. From a contemporary print.

Telling one of his visitors about the invention of the phonograph. In the foreground may be seen an example of his first type of talking machine, in which sound was recorded on a soft sheet of tinfoil fastened around a metal cylinder. These early machines, on one of which Edison's was the first recorded voice, were operated by hand.

The inventor as he appeared about twenty five years ago, in his chemical laboratory at Orange, N. J. Edison has more than a thousand patents to his credit in America. At one time he had under experiment no less than forty five different inventions.

Of late years Edison has welcomed many distinguished visitors to his winter home at Fort Myers, Fla. When this photograph was taken, about ten years ago, his guests were Henry Ford, holding the cane at the right, and the late John Burroughs, famous naturalist (at left). At Fort Myers Edison has conducted experiments to manufacture rubber from weeds.

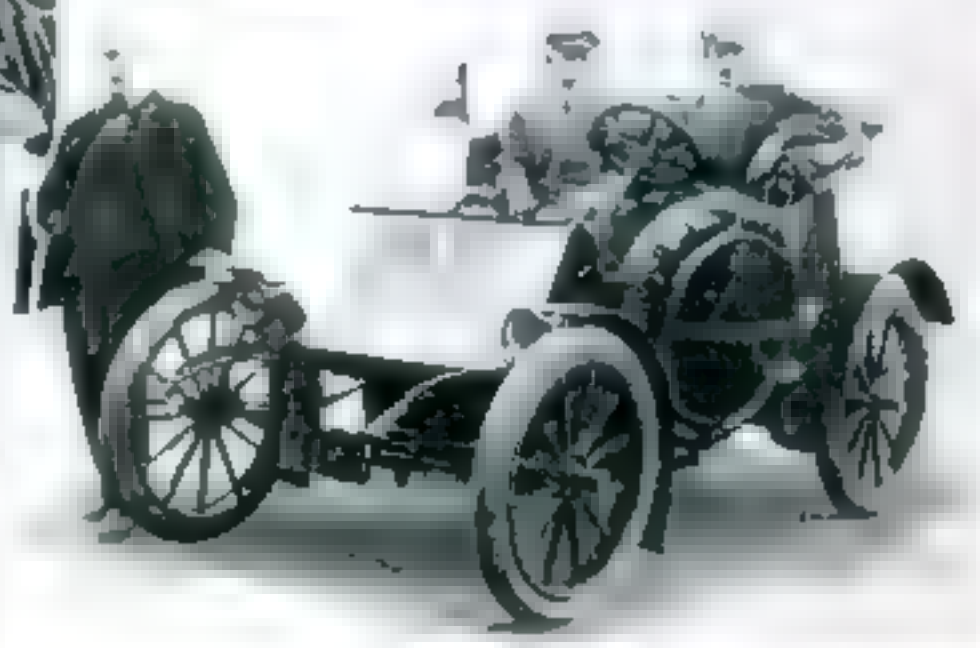
Since Edison made the first crude phonograph talk back to him in 1877 he has never ceased working to improve it. This photograph of about 1902 shows him putting an experimental cylinder on piano reproducing apparatus in the laboratory at Orange, N. J. Note the very long horn which leads to the sounding board of the piano.

Edison at the age of sixty-five in the chemical laboratory at Orange, N. J. His prominence in chemistry began when a boy eleven he aged by a substance in the cage of parakeets. Later he worked as a railway newsboy on Michigan, later money to put back the grass for his earlier

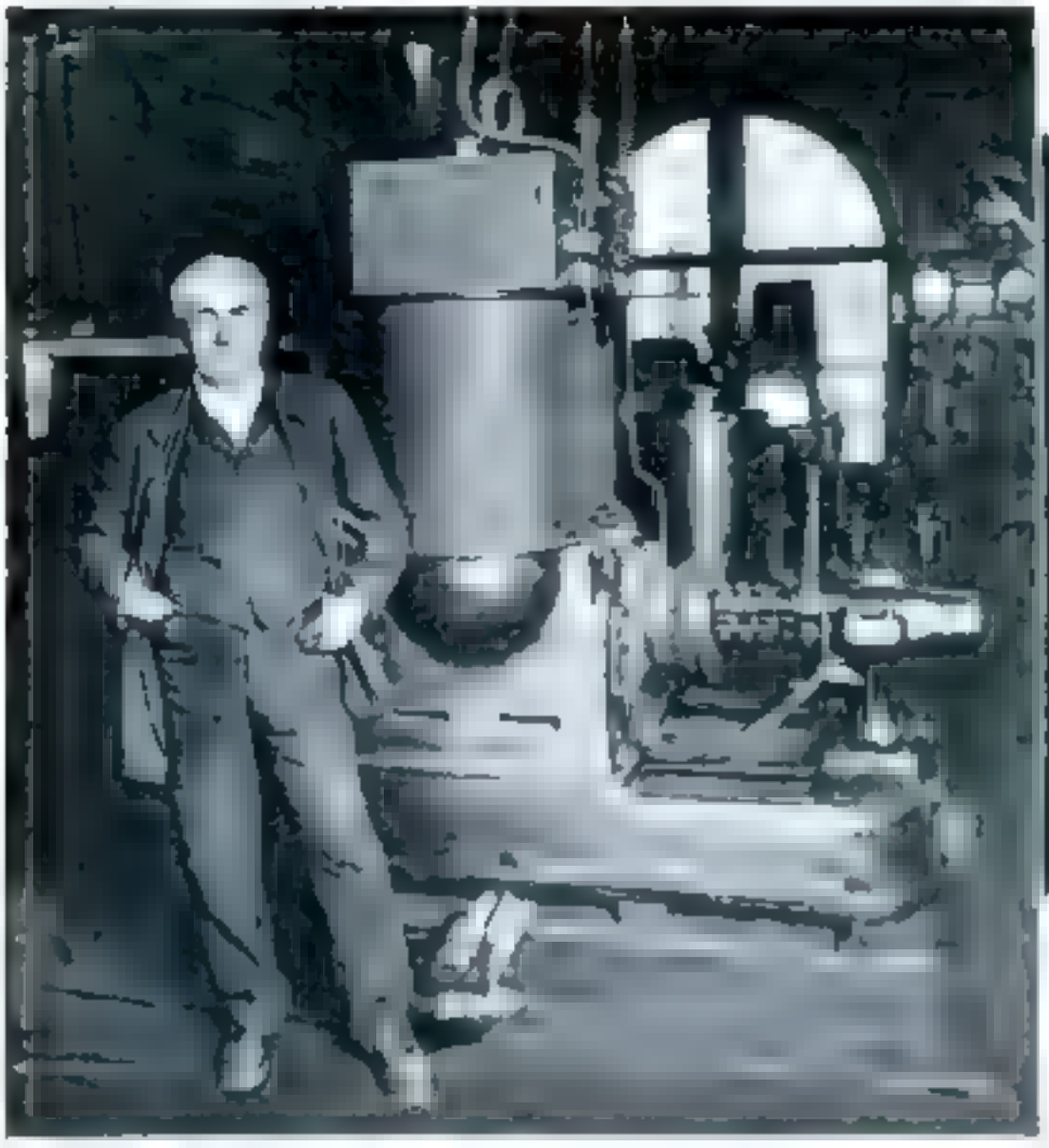
In the years preceding Luther Burbank's death in 1926 the plant wizard and Edison were great friends. Here they are in the garden of the former's home at Santa Rosa, Calif., in 1915. From Burbank Edison received many very useful suggestions on his experiments with rubber producing vegetation.

The storage battery electric car which Edison developed about twenty years ago to attain speeds of which not be ashamed. Above a rear view showing the heavy battery. At the left Edison is shown waving his hand at the motorman's cab.

Edison and his famous "Insomnia Squad" during in the laboratory at Orange, N. J., during their feverish experiments to perfect Edison's diamond disk phonograph in 1910. For nearly six weeks these men worked day and night without leaving the laboratory a feat of remarkable physical endurance. The inventor is seated at the extreme right.



Edison standing beside the Bailey electric auto of 1912 operated by the Edison Storage Battery. In an endurance test it ran for 1,000 miles without trouble. Today the long life battery which he invented in 1908 is used not only for vehicles but for rural and railway lighting systems as well.



Edison standing beside one of his early electric dynamos of the bi-polar type. Up to the early nineties of the last century generators of this kind were used for isolated lighting plants and for the first central distributing stations. The development by Edison of the dynamo and of systems of centralized distribution of current has brought about revolutionary sweeping changes in industry.

Edison always has made it a point to be on the job with his men and on time. Above he is seen punching the time clock in his Orange plant. His vast capacity for work is clearly evidenced by the time slips at the right.

Edison with his son Charles, photographed about twenty-five years ago. As President of Thomas A. Edison Industries Charles Edison today directs the extensive enterprises created by his father including the Edison Phonograph Distributing Company, Edison Storage Battery Company, Edison Portland Cement Company and Wm. Cabinet and Panel Company.

The inventor at his attic table in the chemical laboratory at Orange examining reports of experiments. This striking picture of him at work was taken about 1903.

At the left is the cot in Edison's library at Orange where the inventor has snatched his brief hours of rest for the last twenty-five years or more. His enormous achievements have been made possible not only by his ability in original thinking but by a rugged physical constitution which has enabled him to continue his studies and experiments both day and night with a minimum of sleep.

Busy at a work bench in his Orange laboratory about 1902. Men who have worked with Edison say they never have seen him discouraged—even when days of drudgery and repeated experiment have met only failure.

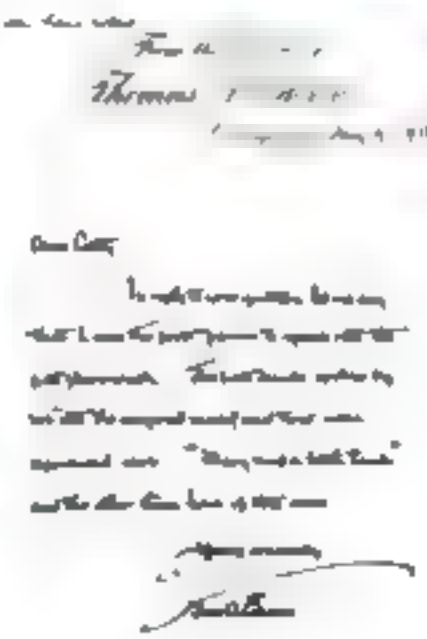
Governments and universities of many nations have conferred high honors on Edison. Here he is with Dean Andrew Fleming West of the Princeton University Graduate School, after having received an honorary degree of Doctor of Laws.

One of the few times when Edison was caught napping. The photographer found him enjoying an outdoor siesta on a camp cot during a vacation in Canada.

A model of the poured concrete house proposed by Edison in 1909. Owning a large plant for grinding and preparing cement, his scheme was to extend the concrete industry by making houses poured into iron frames. A full-sized house was never completed.

Out of Edison's invention of the phonograph grew the dictating machine which has become a necessity in many large business offices. This picture taken in 1911 shows the inventor speaking into the Ediphone in his library.

Pitching the first ball for an Edison Works baseball game at Orange. Though he never found time to engage in sports himself, Edison always was a great rooter for the home team.



The letter reproduced at the left was in reply to one from Gen. John J. Carty, telephone pioneer Vice President of the American Telephone and Telegraph Co., asking what words were first reproduced by the original phonograph.

The Edison of nearly thirty years ago, at work with a microscope. At about this time he spent most of his hours in the chemical laboratory working out improvements in his storage battery for uses in transportation and lighting.

Among the recent applications of Edison's storage battery have been its uses for miners' lamps and mine locomotives. This photo of 1928 shows the inventor examining an improved electric safety lamp.

Of late years Edison has tested hundreds of different kinds of latex-producing plants in his search for an economical substitute for rubber. Here he is making notes on one of his experiments.

When two of the world's greatest electrical geniuses put their heads together. Edison and the late Dr. Charles P. Steinmetz of the General Electric Company discussing new apparatus in the office of the latter at Schenectady, N. Y., in 1922.

As a young man Edison made his start in life as a telegraph operator back in the 1860's. After sixty odd years he can still send a message in Morse code as he proved when this photo was taken.

The face of the Congressional medal presented to Edison early this year to recognize his services.

Never too old to learn. Edison at the age of eighty-one taking a lesson in rubber production from Harvey S. Firestone, noted tire manufacturer. Firestone (at right) and an assistant are demonstrating to the inventor how rubber trees are cut for the latex to flow. This photograph was taken at Fort Myers, Fla., last year.

Obverse of medal, bearing the inscription: "He illuminated the path of progress by his inventions."

Drawn especially for Popular Science Monthly *by B. J. Rosenmeyer*

Merlin Hall Aylesworth, Showman of Radio

As president of the National Broadcasting Company, this minister's son has transformed broadcasting from a more or less haphazard novelty show into America's newest "big industry." In less than three years he has woven sixty scattered radio stations into a nation-wide network of entertainment, news, and education, building a system which can carry a single program to fifty million listeners.

Feeding 13,000,000 Radio Sets

The Head of a Nation-Wide Broadcasting Chain Tells How He Delivers Entertainment and News to a Vast Audience of Fifty Million People

By FRANK PARKER STOCKBRIDGE

IN LESS than three years radio broadcasting has grown from a kind of hit-or-miss novelty show to almost a domestic necessity from a scattering of small, independent, and often irresponsible enterprises to the newest of the nation's "big businesses." The days of "fishing around" to pick something out of the air besides amateur night programs have swiftly vanished. Instead the owner of the average radio set, in almost any remote district of the nation, can readily bring in the finest broadcast programs of entertainment, news, and education. He can hear, across the continent, the inauguration of a president, a symphony concert, a championship football game, or news of the latest ocean flight. The best in radio is at his finger tips.

All this has been brought about by system—by skillfully gathering the loose ends of broadcasting and tying them into a scientific, orderly business of serving the public.

The secret is chain broadcasting.

THE best in radio for everybody, everywhere—it is an immense achievement. And it becomes doubly impressive as Mr. Aylesworth, in this interview, traces the businesslike, scientific system by which nation-wide broadcasting has been developed. What he says will make you appreciate more than ever what your radio set brings to you.—The Editor.

The other day, I talked with an earnest young business man whose vision and leadership have done much to forge the links in the radio chain. He is Merlin Hall Aylesworth, the forty-two-year-old head of the National Broadcasting Company. In his Fifth Avenue office, in New York City, he explained to me the inner workings of the system which connects sixty broadcasting stations by wire, sixteen hours a day, every day in the year, and which carries the best radio talent to 50,000,000 persons or more in every part of the country.

CHAIN broadcasting was an experiment when Aylesworth tackled it early in 1927. Under his direction it has answered, among other things, a question that puzzled all concerned in the days when listeners fiddled with cat whiskers and crystals on homemade sets: "Who is going to pay for programs?"

England solved the problem by imposing a government tax on receiving sets and using the money to run government-operated stations. In America, however, chain programs, paid for by advertisers and radio manufacturers, form a large part of broadcast entertainment.

"Briefly, what we have done by chain broadcasting," Mr. Aylesworth told me, "is to bring the best programs of New York stations within reach of all. By eliminating the element of distance, we have made it possible for anybody, anywhere, with any type of good radio receiver, to hear the best features on the air. Previously, only a few independent stations could afford to broadcast such features and only a fraction of the radio audience could hope to pick them up.

"We have changed all this by connecting some sixty stations, all over the country, with leased telephone wires. The program offered by any one of them can be broadcast simultaneously by them all. Almost every part of the United States is within easy pick-up distance of one or other of these associated stations."

Though the average time of the chain programs is only three and a quarter hours a day per station, the telephone company receives pay for the wire hook-up for sixteen hours every day in the year. Some stations broadcast all the chain programs; some use hardly any of them; all broadcast purely local features at times. But the special wires of the nation-wide hook-up must be kept open at all times in readiness to give the whole country unusual features or news.

THESE wires, Mr. Aylesworth explained, run in pairs from WEAF, the principal station of the National Broadcasting Company, to every other station in the chain. For instance, one circuit directly connects Los Angeles, Calif., with WEAF. Last season, a football game played at Los Angeles was broadcast over the chain. Though the Los Angeles station was only a mile from the football field, the report was telephoned direct to New York, through the control room of WEAF, and back over the wires to the Los Angeles station and to all other stations in the chain. It had traveled 6,000 miles by special wire before being broadcast to the people who lived almost next door to the field where the game was played.

"But, why wires?" I asked. "Why not increase the power of your best station and reach the other fifty-one by radio, having them rebroadcast on their individual wave lengths?"

"Try and do it" was his answer. "In the present state of the radio art, it cannot be done. Part of the program would get through. Part would be lost by fading, static, and interference. Because atmospheric disturbances and interference do not affect wires, we pay the American Telephone and Telegraph Company $2,000,000 a year to keep our stations connected. Some day engineers may show us how to get reliable communication between stations by radio, and we are experimenting in that direction."

Only one station, WEAF, is owned by the National Broadcasting Company. It operates one other, WJZ. All associated broadcasting studios throughout the country are connected with these key stations in chains known as the Red Network, the Blue Network, the Pacific Coast Network, and in five smaller groups independently owned and operated. They can take the chain programs or not, as they choose.

EVERY associated station that broadcasts a sponsored program for which an advertiser is paying receives fifty dollars an hour. If all the stations take a sponsored program, the advertiser must pay the price of nation wide publicity. This means $9,230 an hour with the Red Network of forty-two cities connected with WEAF, or $7,960 an hour with the Blue Network of thirty-three cities connected with WJZ.

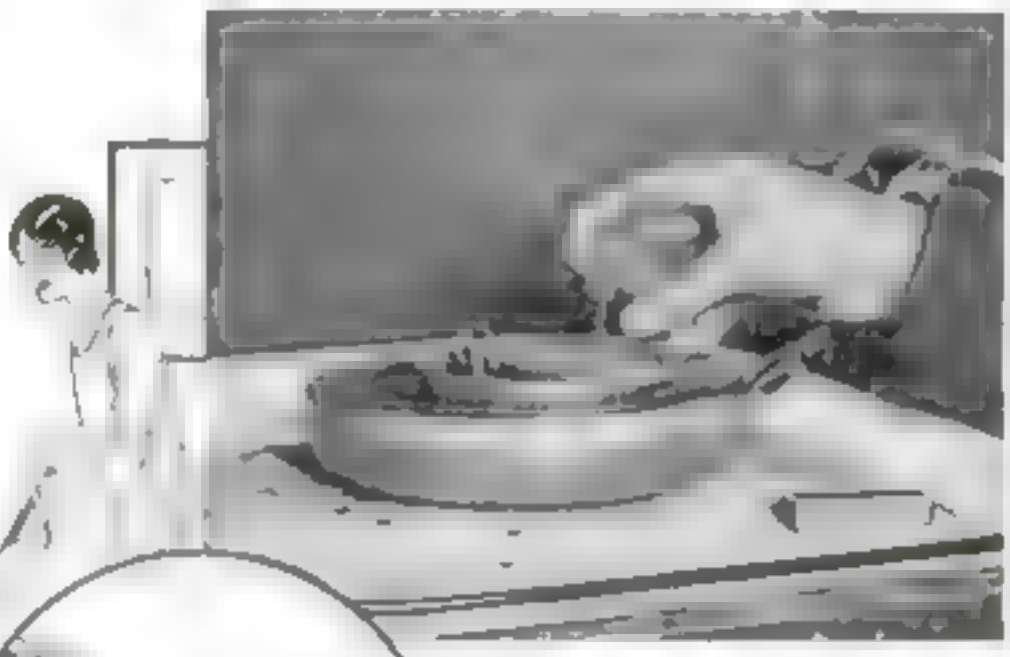
In such programs, Mr. Aylesworth explained, there is only perhaps one percent of direct advertising and not more than twenty percent even of indirect advertising. The programs put on for advertisers are almost entirely entertainment.

"Do you ever censor programs as they are being broadcast, switching off connections when a speaker says something disagreeable?" I asked. "You have been accused of that." (Continued on page 153)

Everyday Wonders in Colloid Chemistry

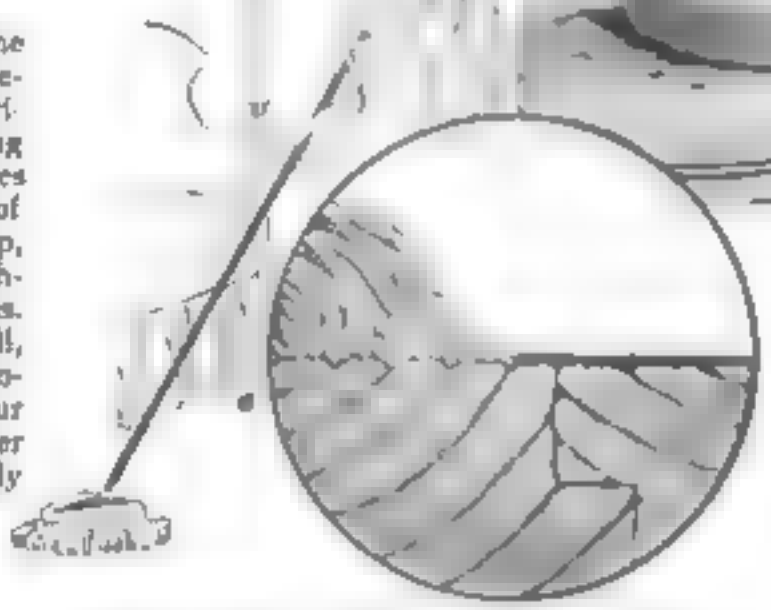
By E. E. FREE

BEHIND a somewhat ponderous name lies a new chemical science—one which opens a field of revolutionary importance, yet also explains in astonishing ways some of the most familiar facts in the world. In this article one of the first American investigators in the field of colloid chemistry tells how it is answering such riddles as why postage stamps stick, why jelly jells, and a host of others.—The Editor.



Oil colloids have important electric as well as mechanical properties. The photo above shows how electric properties are tested for insulation in the laboratory.

TWO chemists of the United States Department of Agriculture were testing recently some recipes for chocolate cake. A few of the cakes came out a deep, rich brown, like old-fashioned chocolate fumbles. Others turned out a dull, brownish gray. The chocolate was the same, the flour was the same, milk and other ingredients were not notably different. What caused the differences in color? The answer, experiments showed, was colloid chemistry.



How a drop leaves a colloidal film of fruit oil for a smooth covering over the lines of rough wood.

Thousands of elderly persons all over the world find themselves slowly going blind. Doctors call the trouble cataract; a slow clouding of the lenses of the eyes. What causes cataract? Dr. Jacques Mawas, in his recent book on eye diseases, blames it on improper colloid chemistry.

Last winter the United States Post Office Department asked the Bureau of Standards to investigate complaints that postage stamps were not sticking properly to envelopes in the mails. The investigation exonerated the stamps and blamed the trouble on envelopes and careless stamping. How were these investigations made? Again, methods and principles were those of colloid chemistry.

A LITTLE past midnight on the morning of March 13, 1928, the St. Francis Dam, a storage reservoir of the water system of the city of Los Angeles, collapsed, carrying scores of sleeping ranchers to their deaths in one of the great disasters of the century. Why did the dam fail? Geologists blame it on facts of colloid chemistry

In the laboratories of great flour mills experts use the methods of colloid chemistry to test the quality of flour. Manufacturers of drugs use colloid chemistry to make forms of gold, silver, arsenic, and other poisons which are safe for use in medicine.

Every housewife who beats up a salad dressing, every man who shaves, every person who uses soap to help wash away dirt, is employing colloid chemistry. A distinguished American chemist remarked recently that the age of synthetic chemistry is almost over. To replace it, he continued, will be the age of colloid chemistry.

This revolution is happening so gradually that most people have scarcely noticed it. Courses in colloid chemistry are given in a few universities. There are mentions of the new science now and then in the newspapers. But for most people it is merely a mysterious new name.

Dr. Daniel T. MacDougal of the Carnegie Institution measuring growth of a tree. He finds that colloidal reactions control the growth.

ACTUALLY, it is more like a new understanding. Facts about colloids are as old as mankind; older, in fact, for all living matter is made of colloids. Colloids mean things like glue; for glue, in Greek, was "colla." That was the only way that colloids could be named when they first attracted scientific attention, for nobody then had any idea of their real character. All that anybody could say was that typical ones among them were sticky, formless things like glue or white of egg or chewing gum, things quite different from clear, crystalline substances like diamond or rock crystal or sugar. Colloid chemistry grew up as the chemistry of glue-like things, just as sugar chemistry deals with the reaction of sugars, or metallurgy is the chemistry of metals. It has its synthetic phases and its analytic ones. Some colloids can be made synthetically just as some sugars can. Sometimes colloids need to be tested, as analysts assay metals.

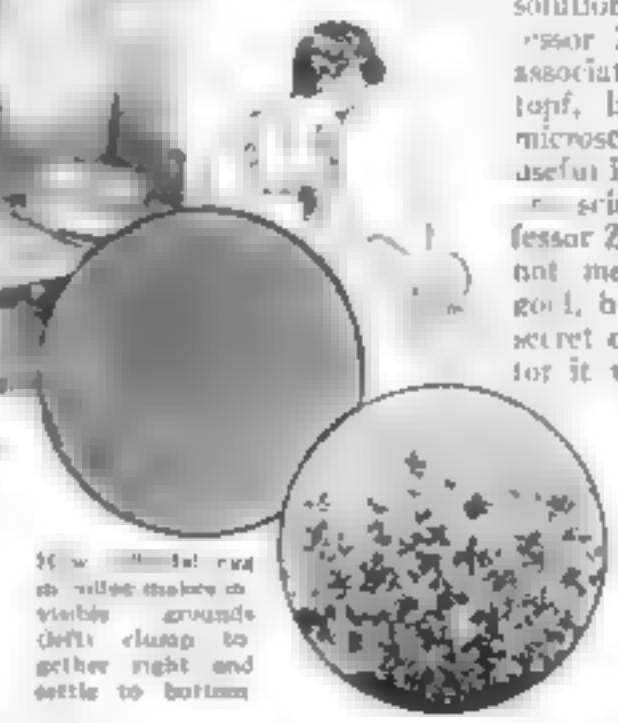
Nowadays it is known that all colloids have significant family resemblances in internal

Laboratory tests as put to here prove that [illegible] and dough [illegible] the mixing, the baking and [illegible]

structure, just as all the higher animals have similar skeletons, or all wood is made up of fibers. The discovery of these internal likenesses is one reason why colloid science has grown so rapidly. As long as ten thousand years ago potters knew how to shape lumps of clay into pots and dishes; now called a colloid chemical art. In the days of Julius Caesar wine makers knew how to clarify their wines with clean white clay, another application of colloid chemistry. These arts had been learned accidentally. Nobody really understood them; so they could not be improved.

THE key to understanding was made of gold. Fifty years ago John Tyndall, the same British physicist whose lectures on popular science made him both rich and famous, used to show his audiences an experiment still called the "Tyndal Effect." A powerful beam of light is sent through what seems to be clear water. Instantly the beam becomes luminous, as though the water in its path were on fire. A similar effect is seen when the powerful light beam of a magic lantern or a motion picture projector passes through the air in a dusty or smoky room.

Nobody understood this effect until a German chemist, Professor Richard Zsigmondy, began working, about thirty years ago, with solutions of pure gold. If gold leaf is reduced to a sufficiently fine powder and that powder suspended in water, the result is merely a temporary gold suspension like a stirred-up mixture of water and sand. In a moment or two the flakes of yellow metal settle out on the bottom, leaving the water clear. Flakes of pounded gold are known to have been suspended in just this way in one or two of the rare and curious liquors manufactured by medieval monks. But if metallic gold is first dissolved in acid and that solution mixed with water, the gold never settles out. Thus is made, for example, the slightly yellowish solution of gold chloride which photographers once used to make gold-toned prints. The chief difference between this and the suspension of golden flakes is in the sizes of the particles. In the ancient gold flecked liquors the particles were large enough to be seen individually and to settle out quickly. In the photographer's solution the gold particles are so tiny that they are invisible and never settle. Many of them are single gold atoms.



[illegible] gold [illegible] yellow flakes on visible grounds [illegible] together right and settle to bottom

PROFESSOR ZSIGMONDY knew, however, that it is possible to make remarkable solutions of gold which are not like the usual ones in acid or like the gold flecked suspensions. Some of these are pink or crimson in color; others are a clear sky blue.

To find out what these beautiful gold solutions really were, Professor Zsigmondy and an associate, Dr. H. Siedentopf, invented the ultramicroscope, one of the most useful instruments of modern science. With it Professor Zsigmondy explained not merely red and blue gold, but the fundamental secret of colloid chemistry, for it was discovered that these colored solutions were really colloids.

Once learned, the secret proved as simple as the greater secrets of Nature usually are. It is merely a matter of the sizes of particles. Large gold particles the size of sand grains are yellow and immediately settle out of water. Very small gold particles about the size of atoms are invisible and stay in solution forever. Between these two classes there is an intermediate group of particles larger than atoms but not so large as the grains of golden sand.

THESE medium-sized particles, like a race intermediate between giants and dwarfs, make the colloids. The smallest gold ones, just a little larger than atoms, color the water rose pink. Particles a little larger create the crimson gold solutions. A trifle larger still, they show a violet tinge. The largest of all, not much smaller than visible gold flakes, produce the blue gold solutions, like the blue of the sky.

Nowadays this knowledge of gold colloids is put to practical use in making ruby glass, some of the best grades of which owe their brilliant red and purple tints to the presence of myriads of tiny particles of colloidal gold, scattered through the glass.

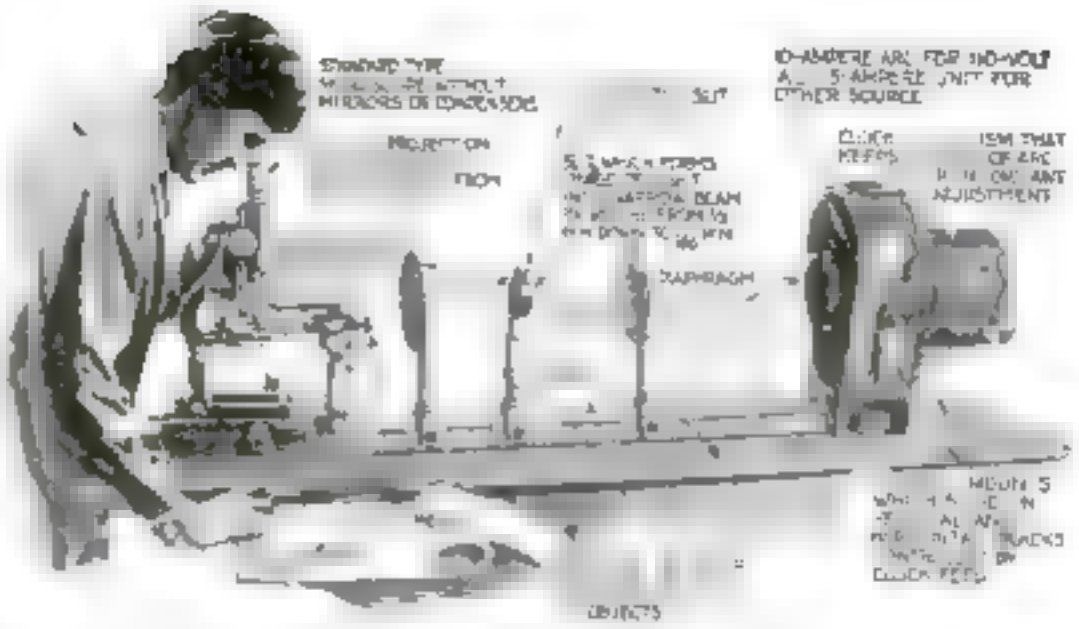
These colloidal particles are too small to be seen under any modern microscope. Even the ultramicroscope does not disclose them directly. What it does do is to illuminate a tiny slice of the colloidal solution with a very intense beam of light, much as in Tyndall's experiment with the beam of light made visible in water. This illuminated slice of the solution is then viewed from above through high-power microscopic lenses. The eye then sees a marvelous spectacle of moving, interlacing points of light, like a million dancing fireflies. These are the colloidal particles, themselves too small to be seen but each of which reflects its tiny visible light ray.

The unending dance of the particles

With microscopic knives in this laboratory apparatus scientists dissect single cells so that they may prove the colloidal nature of living matter

Delicate pegs on a penetrating needle of this instrument test the stiffness of jelly which is a colloidal property important both in foodstuffs and in the protoplasm of living cells.

is an example of the famous "Brownian Movement" first seen a century ago by the Scotch physician, Dr Robert Brown, who noticed the similar motions of visible dust particles in liquids under his microscope. Dr. Brown's visible particles merely slid around sedately like slowly-revolving waltzers. Their size keeps them sluggish. The tinier particles of the colloidal solutions dash madly in every direction, seemingly yards at a time, like the violent acrobatics of a Russian ballet. What causes all the motions is now known to be a bombardment by the continual quivering of the atoms and molecules of the liquid.



The ultramicroscope, chief instrument for the study of colloids. It reveals colloidal particles, which are too small to be seen individually as dancing points of light

ONE service of this beautiful ultramicroscopic dance is to give a clue to an important property of nearly all colloids—providing, incidentally, an explanation of why egg clears grounds out of coffee.

Under the ultramicroscope the colloidal particles may be seen to die as well as dance. The dancing light specks of colloidal gold can be killed by allowing a tiny trace of acid to diffuse into the droplet of solution under the ultramicroscope. The dance comes instantly to a tragic end. The tiny particles rush together into clumps, too large for dancing, like ballroom guests in sudden panic. From a test tube full of the colloidal gold solution thus treated with acid, the color vanishes. Presently a trace of dusty, brown powder collects on the bottom. That is the once-colloidal gold

How colloids in shaving soap form a smooth film over the skin, so that the razor slips along without catching.

THIS clumping of colloidal particles is what is called "flocculation," and is what happens to the egg in coffee. Both the white and the yolk of an egg are colloidal materials. Dumped into hot coffee, the egg colloid flocculates. The larger clumps and flocks thus formed rapidly settle. As they do so they sweep down to the bottom of the coffee pot the powdered coffee grounds which were not heavy enough to settle by themselves.

Avoidance of this flocculation is the explanation of the rich brown chocolate cakes studied by two chemists of the Department of Agriculture, Miss Emily Grewe and Dr E. O. Whittier. The ingredient found to produce these deepest browns was baking soda. This chemical is known to oppose the flocculation of colloids. In the cake it keeps the fine powder of the chocolate in separate particles, which makes it most effective in producing the brown color. With too little soda the acids of the milk or other ingredients flocculate the chocolate particles, damaging the color.

Smokes and fogs are other colloids to which these facts of flocculation apply. They are solid or liquid particles scattered in a medium which happens to be gaseous instead of liquid. Otherwise they act just as the colloidal solutions of gold particles. The Brownian Movement may be seen beautifully in a wisp of cigar smoke under the lenses of an ultramicroscope. Fog or smoke can be flocculated and made to vanish just as the egg colloids are flocculated in the coffee. This possibility, in fact, offers what is probably the best line of attack on the problem of dispersing fog, now so important to aviation. Even the blue color of the noonday sky and its frequent red color at sunset are colloidal phenomena due to the action of tiny floating particles on sunlight, just as the particles of colloidal gold act on light rays to make those colloids red or blue.

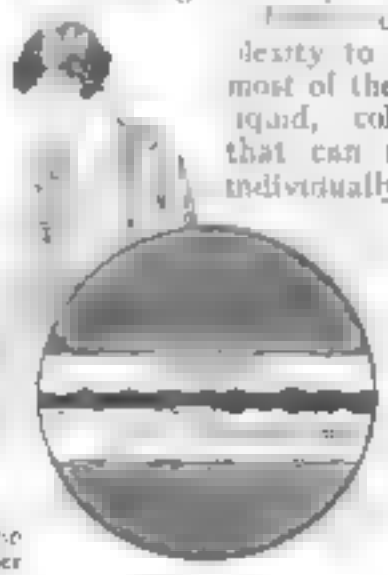
COLLOIDS possess, of course, many other unusual properties. One of these, for example, is an enormous spread of surface, for an ounce of gold in the form of colloidal particles has millions of times more gold surface than the same amount of gold in the form of gold leaf or of a gold coin.

This multiplication of surface is highly important in the chemistry of the process called catalysis, by which new reactions are worked and new compounds made by the mere presence of the catalyst. Colloids are among the best known catalysts; but this is too long a story to be more than mentioned here.

ONE great group of colloids familiar to every housewife includes all kinds of salad dressings and jellies. The particles that float in air to make a smoke-colloid or in water to make colloidal gold are solid ones. It is just as possible to make liquid particles float as colloids; liquid vinegar, for example, beaten up in olive oil to make a salad dressing. Milk and cream are other similar mixtures, for these fluids consist, the ultramicroscope shows, of tiny liquid particles of fat and oil scattered through a watery fluid. Making butter is no more than flocculating this milk colloid so that some of the fat particles stick together to form the butter while the watery liquid is left to make the whey.

A housewife who makes salad dressing has just the opposite intention from the butter maker. She wants to keep the dressing from flocculating. If it does flocculate accidentally she says that it "breaks" or separates, the oil into one layer, the vinegary water into another. Chemists now know several harmless materials which may be added to oily and watery mixtures to prevent this colloidal flocculation, so that salad dressings will last longer and will stand more warming or handling than they used to do.

How [illegible] fuse up the underslope of a paper envelope to make the stamp stick.

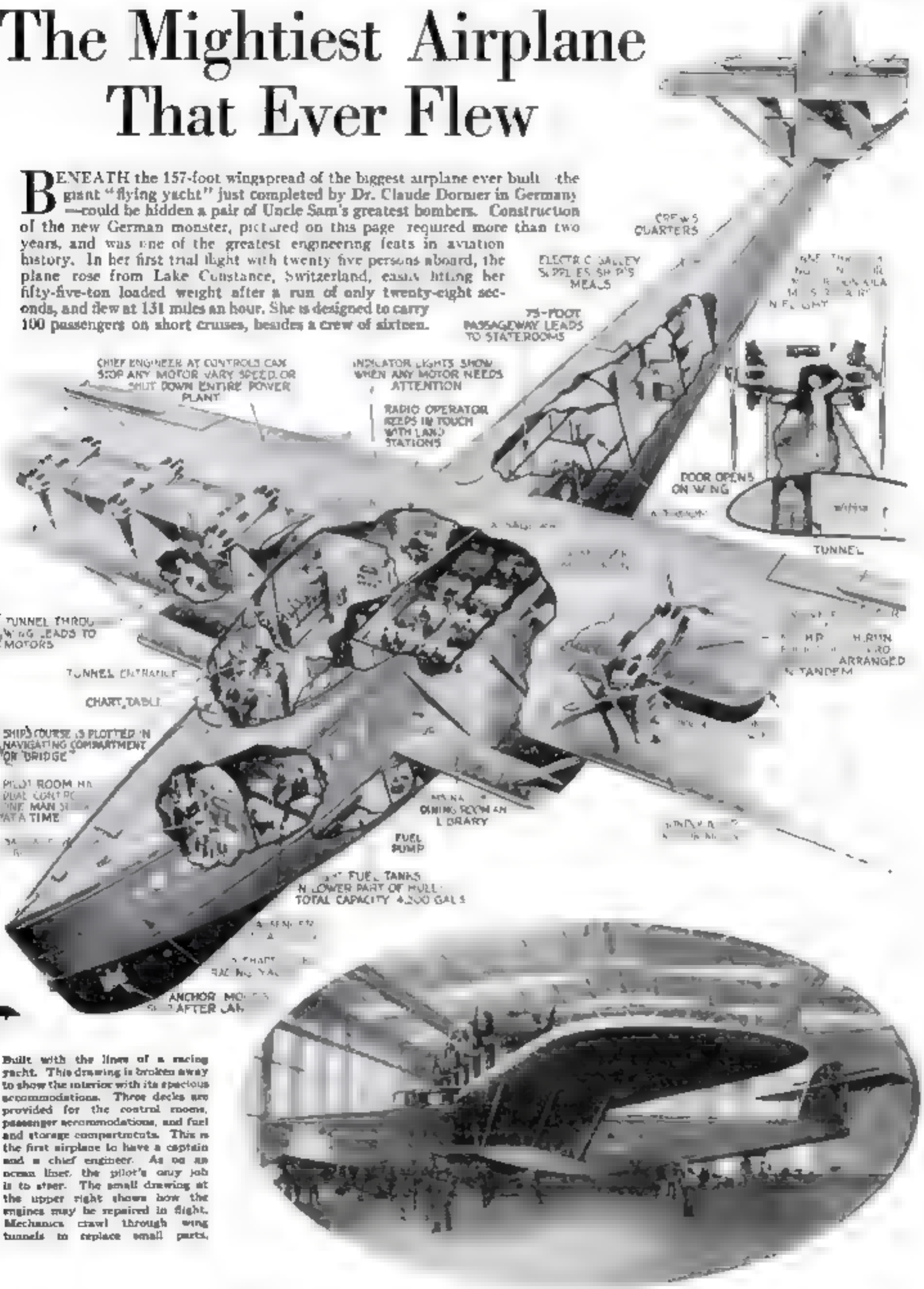


Added another complexity to the picture, for most of these contain tiny, liquid, colloidal globules that can shrink or swell individually while they are suspended in the solution. If a human being could pass himself through some kind of mechanical ultramicroscope, come out the size of an

Continued on page 163

The Mightiest Airplane That Ever Flew

BENEATH the 157-foot wingspread of the biggest airplane ever built—the giant "flying yacht" just completed by Dr. Claude Dornier in Germany—could be hidden a pair of Uncle Sam's greatest bombers. Construction of the new German monster, pictured on this page required more than two years, and was one of the greatest engineering feats in aviation history. In her first trial flight with twenty five persons aboard, the plane rose from Lake Constance, Switzerland, easily lifting her fifty-five-ton loaded weight after a run of only twenty-eight seconds, and flew at 131 miles an hour. She is designed to carry 100 passengers on short cruises, besides a crew of sixteen.



Built with the lines of a racing yacht. This drawing is broken away to show the interior with its spacious accommodations. Three decks are provided for the control rooms, passenger accommodations, and fuel and storage compartments. This is the first airplane to have a captain and a chief engineer. As on an ocean liner, the pilot's only job is to steer. The small drawing at the upper right shows how the engines may be repaired in flight. Mechanics crawl through wing tunnels to replace small parts.

The new Dornier plane, 230 feet long and 33 feet high, just before launching at Lake Constance. It weighs almost *four* times as much as the largest plane previously built, yet can carry as much weight again in useful load.

Back of the Month's News

By

KARL VOOGHT

THE *Pennsylvania*, largest commercial vessel ever built at an American shipyard, was launched recently at Newport News, Va. This 34,000-ton turbo-electric liner of the Panama-Pacific Line will make fortnightly runs between New York and California by way of the Panama Canal.

The new vessel is only one of a bumper crop of sea giants taking to the water this year. The record breaking German liner *Bremen* is described elsewhere in this issue. In England, the *Britannic*, largest motorship ever launched in that country, has just been completed. It has a length of 600 feet, fifteen feet shorter than the *Pennsylvania*. It will be put into service between England and America and used for winter cruises in the Mediterranean.

At the same time, the British Cunard Line announces plans for two 1,000-foot liners, vessels which if placed on end beside the Woolworth Building, would tower 208 feet above it. These ships will exceed in length the world's largest liners, the British *Majestic* and the American *Leviathan*, by nearly 100 feet.

Although the *Britannic* is propelled by Diesel motors instead of electricity, enough electric current is generated and used on board to supply a town of 30,000 inhabitants. It performs a variety of tasks, such as cleaning silver, peeling potatoes, manufacturing ice cream and printing menus. In its elaborate equipment, the vessel is said to contain thirteen miles of pipes and 200 miles of wire. About 3,000,000 rivets were used in its construction. The weight of these alone would equal that of half a dozen average locomotives.

The 34,000-ton turbo-electric liner *Pennsylvania*, largest commercial vessel ever built in America, a moment before sliding down the ways. She will sail between New York and California via the Panama Canal.

Quakes Recorded by Light

THE record of the changing surface of the earth is being kept by a new type of seismograph, installed at Harvard and Fordham Universities, which writes with a finger of light instead of a pen.

The older instruments, in which the tremors of the ground moved a paper under a pen, thus recording the strength of the earthquake, were sluggish in action. But light is without friction, and the slightest shiver of the earth's crust is traced by the new mechanism, giving increased accuracy to scientific records.

A Russian, Prince Gantan, is the inventor of the improved seismographs. One of them, installed in a dark, vault-like room twenty feet below ground at Fordham University, New York City, is so sensitive that a cigarette smoked in the same room will alter the temperature sufficiently to affect its operation.

The instrument is bolted to a concrete pier that extends down to bedrock and is entirely separated from the rest of the building. When the bedrock trembles, twin pendulums on the seismograph swing coils through a magnetic field, generating electricity, the amount depending upon the length of the swing. A sensitive electric instrument, to which the current is carried, operates a movable mirror, tilting it back and forth in proportion to the strength of the incoming current.

A beam of light, directed to the mirror, is reflected to a sheet of photographic paper slowly turning on a drum. If the mirror is still, the line made by the light beam is straight. But when the mirror moves, the line wavers; the height of the waves show the violence of the tremors. The lamp throwing the beam winks at the end of every minute for three seconds, leaving tiny gaps in the record. Thus, after the photographic paper is developed, the exact time and duration and intensity of a quake can be determined.

With such instruments, science will be able to trace baby vibrations, tremors not classed as earthquakes. In India, a similar apparatus is said to have recorded storms at sea through the delicate vibrations caused by waves pounding on a shore a thousand miles away.

Guarding Buildings from Decay

CHEMISTS of the British Government recently advised owners to wash the faces of stone buildings occasionally with hot water and soap to protect them from the action of stone-eating acids in the air.

Erosion of stone buildings is especially rapid in large and smoky cities and in countries of frequent fogs, such as England. A discovery of effective preventive measures will mean an annual saving of millions of dollars.

Carbon dioxide, always present in the air, is one of the gases that combines with building materials to form acid destructive to stone and mortar. But the chief menace comes from coal smoke, especially smoke from soft coal.

Smoke consists largely of tiny particles of carbon which are not burned by the fire and are thrown into the air. When the fuel is soft and easily broken up a greater number of the carbon particles are carried up the chimney before they have time to catch fire. This is the reason soft coal smoke is denser than the smoke produced by hard coal.

In smoky air there is either sulphuric acid or the gases that will combine with rain water to form it. This is known from tests of rain water made at various places. In New York City, for instance, experiments have shown that the equivalent of a thousand tons of concentrated sulphuric acid falls on the roofs and streets of that city every six months. This is sufficient to eat up forty carloads of iron roofing, it has been estimated. Its effect upon stone over a period of years can readily be imagined.

IN THE industrial city of Leeds, England, the precipitation of this acid is even greater. It has been calculated that rain and dust during a single year bring down seven tons of sulphuric acid for each square mile of the city.

Smoke in the air also increases fog in seaport cities, and fog hastens the action of stone decay. Fog, like rain, is produced by drops of water forming about a central nucleus, such as a smoke or dust particle,

but in fog the drops are extremely small, often no larger than one twenty-five-thousandth of an inch in diameter Sometimes, it is said, there may be scarcely more than a gallon of water in a cubic mile of fog.

An Arctic Walrus Hunt

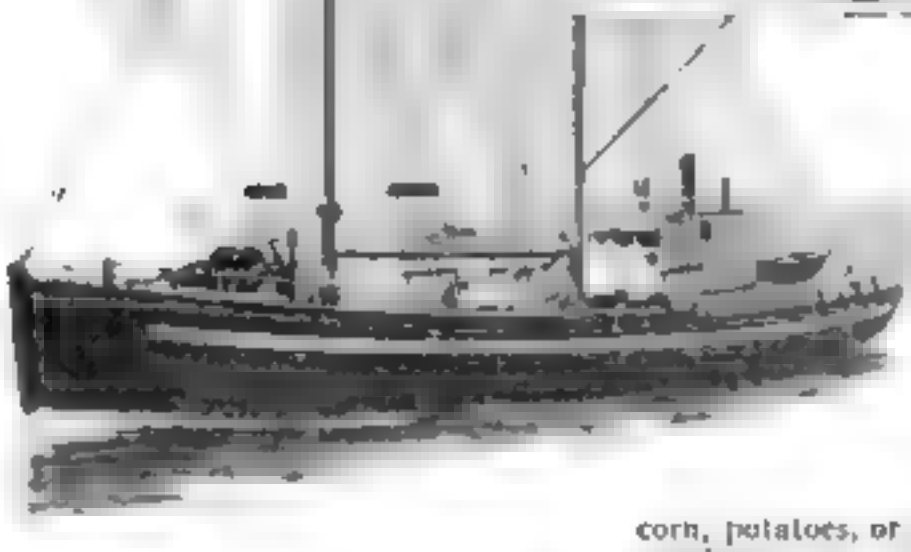
A CHASE that may take explorers of Chicago's Field Museum of Natural History as far north as Wrangell Island, in the Arctic Sea, has as its goal a few fine specimens of walrus. Under the leadership of Bruce Thorne of Chicago and George Coe Graves II of New York, the expedition is sailing in the specially fitted power schooner *Dorothy* into a sea made perilous by floating ice. There they will seek the most difficult of all animals to hunt, and, if successful, bring back several of them to be posed in a nature-study group at the museum.

Nowhere but in the Arctic are these ungainly marine mammals to be found. There are only two varieties, an Atlantic and a Pacific form, both now rapidly becoming scarce and confined to the upper regions of the Arctic. Years ago walruses were plentiful along the coast of Alaska, while they ventured as far south in the Atlantic as Newfoundland on the west and the north of Scotland on the east. They were hunted for their oil, for their hides, and for the ivory of their drooping tusks. Harpooners in boats, and hunters who shot or stabbed them on land, have all but accomplished their extinction in recent years.

Striking in its physical appearance, a full-grown walrus may attain a length of twelve feet, and may weigh as much as 3,000 pounds. They are harmless, except when attacked. The Field Museum's expedition, if it is lucky, may encounter a school of these animals, for they herd together in a remarkably developed social organization.

An unusual photograph of a herd of walruses asleep on an ice floe in the Bering sea. A full grown walrus may weigh 3000 pounds.

Feeding a baby walrus from a bottle. The young walruses are covered with short brownish fur which rubs off with advancing years. The animals are nearly extinct.



Specially fitted power schooner *Dorothy* in which explorers of the Field Museum of Natural History are sailing into the Arctic hunting walrus specimens.

Farming for Chemicals

FARMS of the future will be devoted to producing chemicals instead of fruits, grains, and vegetables; they will raise the raw products for the chemist's laboratory to convert into table foods, and yields will be spoken of in terms of carbohydrates, acids, and chemical compounds instead of so many bushels of corn, potatoes, or wheat per acre. This prophecy was made recently by Dr. Edwin E. Slosson, American chemist and author.

For the farmer such a change would be of vast importance. It would mean efficiency impossible under present methods, with a resulting improvement of rural conditions. For the city dweller, it would bring more nourishing food at lower cost. For the record of the past has shown that when chemist and farmer join hands, profit results.

Not many years ago, southern states passed sanitary laws for the disposal of cotton seeds, which rotted in huge piles beside the gins. Chemists examined this waste—and found a gold mine. From these lowly seeds now come many valuable products, ranging from soaps to nitroglycerin, roofing paint to writing paper, and massage skins to photographic film.

Blackstrap molasses, once a staple, has gone out of style as a table delicacy. But from it, the modern chemist is extracting valuable ethyl alcohol. And from "bagasse," the cellulose pulp left after sugar cane is run through the rollers, more than 200,000 square feet of insulating board was made last year.

Formerly, citrus growers of California paid a dollar a ton to get rid of the waste products of their oranges and lemons. Now, these same wastes are converted into citric acid and oils, yielding the growers a million dollars a year.

The chemist turns waste to wealth. From common peanut shells, high grade cellulose, worth $4,500,000, may be produced annually, according to Charles H. Herty, noted New York chemist.

When the corn borer began to menace the fields of the Middle West, the farmers were forced to collect their cornstalks to prevent the spread of the pest. In the search for a means of disposing of this waste, methods were discovered to convert it into paper, artificial silk, and synthetic lumber. From another product of the grain fields, oat hulls, recently has been extracted furfura, the oily liquid used in making synthetic resins.

Sports by Lamplight

A GAME of midnight golf was played recently at Cleveland, O., on a miniature course illuminated by powerful electric lamps. Workers who are kept indoors during most of the daylight hours may take advantage of the artificially-illuminated playground for evening sport.

Golf is not the only pastime that has been made possible at night by the electric lamp. Veteran marksmen, not long ago, met at Lynn, Mass., for an outdoor night trapshooting contest. Floodlights, totaling 2,000,000 candlepower, were used. So satisfactory was the man-made sunlight that some of the contestants broke as many as twenty-three out of twenty-five clay pigeons.

Annie Oakley, famous girl rider with the Buffalo Bill wild west shows, is said to have been one of the first to do fancy shooting under artificial light outdoors. At the evening performance of the circus, she would break glass balls thrown into the air as she dashed past on a broncho. A double row of arc lamps, equipped with burnished reflectors, provided the light.

In various parts of the country, football, baseball, and soccer fields, and tennis courts, are now provided with powerful electric lamps that make night playing

The [illegible] window [illegible] the cathode ray [illegible] be [illegible] it is absolutely safe-proof

possible. The "ghost ball [illegible] ball painted white [illegible] be[illegible] bu[illegible] l[illegible] American universities b lighten sh[illegible]

Testing the quality of rough sapphires by placing them, in a tray, beneath the window of a cathode ray tube.

How a quartz glass [illegible] strange light when [illegible] the cathode rays.

Cathode Rays Test Gems

SAPPHIRES glow and tell the story of their origin through the latest application of cathode rays. Engineers of the General Electric Company, searching for a way to test the quality of the million and a half jewels they use each year as bearings in meters and other delicate electric instruments, were astonished recently to discover that the electric cathode ray tube devised by Dr. W. D. Coolidge of the same company offered a perfect test.

When a tray of artificial sapphires is placed under the rays, in a darkened chamber, the stones glow with a mysterious light, and continue to glow for a time after the rays are turned off. Natural sapphires, on the other hand, cease to glow as soon as the rays stop; in fact, one variety does not glow at all.

By this test and by the color of the radiance, engineers not only determine whether the gems are synthetic or natural, but can even name the factory that made the synthetic gems, or say where the natural ones were found.

"Should sapphires from Montana be mixed with stones from Australia, we could find this out with the cathode rays," said B. W. St. Clair, of the General Electric Company's standardizing laboratory at Lynn, Mass.

Three years ago Dr. Coolidge demonstrated the first modern generator of these extraordinary rays at the Franklin Institute, in Philadelphia. With a glass tube about three feet long, enlarged at one point into a spherical bulb, and an electric dynamo, he performed such feats as making a white mineral called calcite glow with orange radiance, turning acetylene gas into a mysterious yellow solid, killing insects, and destroying the tissue of a rabbit's ear.

Dr. Coolidge had not, as one report had it, discovered a new ray. But he had turned the feeble ray, discovered by the English physicist, Sir William Crookes, fifty years ago, into a formidable shaft of purple fire that worked marvels which engineers did not understand. He had released rays of undreamed power by placing a window in one end of his tube—a sheet of nickel foil only a quarter as thick as a sheet of writing paper, that allowed the mysterious rays to stream through.

Engineers agree that the "cathode rays" are streams of flying electrons, or electrified particles of matter, very similar to one of the three kinds of radium rays. Hitting the outside air in a darkened room they produce a weird purple light that hangs about the end of a cathode tube. The rays kill insects and small animals. Probably they would kill a man if he stood long enough before them. Yet, Dr. Coolidge explains, his tube will probably not prove a "death ray" machine in time of war, because the highest electrical voltages will not project the rays more than a few feet.

At present the most powerful cathode ray tube in the world is a three-section affair built by Dr. Coolidge last year—really three tubes hooked together, to which is applied the tremendous electric pressure of 900,000 volts. Each of the three sections gives an added "kick" to the flying electrons, so that by the time they reach the end they are moving 175,000 miles a second, the fastest velocity ever created by man. This is about 450,000 times faster than the speed of a bullet shot from an Army rifle. This tube's luminous glow extends six feet away.

Until recently the tubes were laboratory marvels with no known practical use. But not long ago, Prof. H. Plauson, of Hamburg, Germany, announced that with such a tube, he had made synthetic ammonia gas from the air, produced artificial rubber, and made alcohol from coal, air and water. Prof. J. S. Long of Lehigh University, discovered that the rays would dry paint with extraordinary rapidity.

"Sunshine" in Yeast

YEAST is now added to the list of foods that are treated with artificial sunshine from electric lamps. One cake is said to confer the same benefits a person might receive by spending two or three hours in the rays of the sun. The beneficial substance which yeast contains after the lamp treatment, "Vitamin D," is similar to that formed naturally in the human body by the sun's rays and the same as the healthful principle in cod liver oil.

Although the idea of thus taking sunshine by proxy is of comparatively recent origin, already a number of food manufacturers have installed lamps to treat their products. The idea is based upon the fact that the bone-building element, Vitamin D, if absent in a person's regular diet, can be supplied either by sun-bathing, by exposure to lamps that give a light approximating that of natural sunshine, or by eating food that has been treated with artificial sunshine.

Rays of ultra violet light, found in the sun and in the radiations of certain types of electric lamps, are the principal agent in all three methods. Substances beneath the skin, and in foods as well, undergo a distinct chemical change beneath the rays. Ergosterol, a fatty substance, is changed into Vitamin D, and its health-giving power becomes manifest.

The discovery that eating sun-bathed food was as effective as natural or artificial sun-bathing dates from 1924, when Dr. Harry

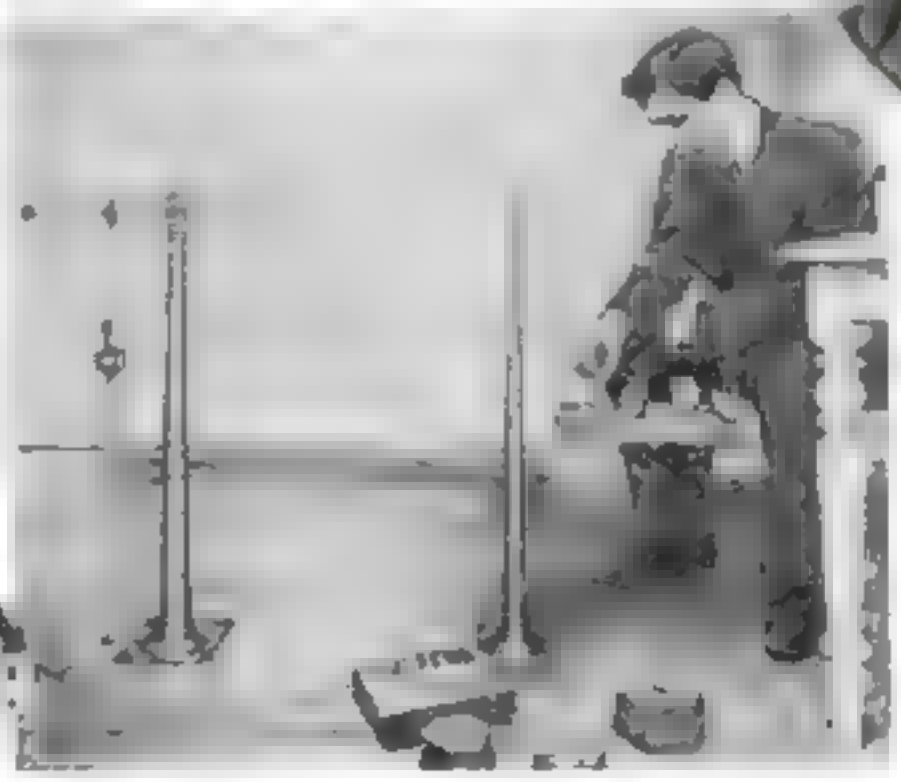
Courtesy General Electric Company

Dr. Harry Steenbock, of the University of Wisconsin, discoverer of the efficacy of sun-bathed food, making a test with ultra-violet lamp.

This view, taken in 1887 when work was begun on the Eiffel Tower, shows the mass of masonry [illegible] of the [illegible]

The last picture of Gustave Eiffel, shortly before his death in 1923 at the age of [illegible]. At the left the young Eiffel is seen in [illegible] experimenting with [illegible] and the pressure of the tower against the [illegible]

The tower after completion of the third platform at the top, in 1889. The intermediate platform is for changing elevators.



Steenbock, of the University of Wisconsin, fed irradiated cereals to rats kept in the dark and cured them of rickets.

In one typical process used by a cereal manufacturer, milled wheat passes on an endless belt beneath the vitalizing glow of a bank of mercury-vapor lamps with quartz, or rock-crystal, tubes. After preliminary steaming and sterilization, the grain is spread in a thin layer on the belt so that the rays can penetrate it thoroughly. After the lamp treatment the wheat is unchanged in appearance, but the brownish-white grains now contain the essential Vitamin D

Addition of yeast to the present list of irradiated foods is another step forward in "bottling sunshine." Today a person who cannot go to the seashore or mountains may have the assurance of scientific experts that he may receive virtually the same benefits in his food.

Tallest for Forty Years

A SIMPLE shaft of white stone about ten feet high, surmounted by a metal bust, was unveiled the other day on the park known as the Champ de Mars, in Paris. Graven upon it were the words, "Gustave Eiffel. 1832-1923." Thus France honors the memory of the man who dared undertake, in 1886, the construction on that site of the tallest structure ever built by man—the 984-foot tower that bears his name today

Although it is by this great engineering feat that he is chiefly remembered, Eiffel had already to his credit a brilliant career that fitted him for the task. He was only twenty-nine when, in 1861, he directed the construction of an important metal viaduct over the Garonne River at Bordeaux, France In the years that followed he designed buildings and bridges, built the movable dome of the observatory at Nice, and constructed the framework for the Statue of Liberty in New York harbor. His reputation as an engineer was made when he designed the huge arch bridge over the Douro River at Porto, in Portugal. Its span of 520 feet was the greatest that had ever been attempted in a fixed railway bridge. He followed this exploit in 1879 with an even greater one, the Garabit bridge the 540-foot span of which crosses a valley more than 400 feet above the Tuyere River, in southern France.

Meanwhile, American engineers had suggested the erection of a 1,000-foot tower at Philadelphia for the exposition held there in 1874. Their plan fell through. In 1881 a Frenchman named Sebillot proposed to build in Paris such a tower, to be constructed of masonry and to be surmounted by an electric plant to light the entire city. His proposal was rejected, on the ground that a tower of such height could not be built safely of masonry

The government, however, favored building a sky-piercing tower for the exposition of 1889, to be held in Paris, and invited architects to submit plans. Eiffel's proposal in 1886 to build one entirely of steel was accepted. It was stipulated that he should build the tower under a government subsidy, retain the concession to operate it for twenty years, and at the end of that time turn over possession of it to the City of Paris

Eiffel set to work on the biggest job he had ever tackled, undismayed by the gloomy predictions of other architects that the wind would surely blow down his tower. Forty draftsmen and calculators worked for two years studying the 15,000 separate pieces that were to go into the structure. They used up 5,000 sheets of yard-square drawing paper. Each of the 15,000 pieces required a separate drawing, showing in particular the position of rivet holes with an accuracy of one-fiftieth of an inch. The rivet holes, numbering 2,500,000 in all, were thus bored in advance in the workshop where the steel members were constructed to size, and when the pieces were assembled they fitted perfectly

On a foundation of more than 15,000 cubic yards of masonry the skeleton structure of steel began to take shape. On March 31, 1889, a little more than two years after work had started, a French flag hauled to the top proclaimed that the mighty 7,700-ton structure was finished. Eiffel had accomplished the 'impossible'

Scientists were not slow to find the dome at the 984-foot summit an ideal weather observatory, and meteorological instruments installed there today record faithfully temperature, wind, and moisture conditions far above the street. At times the tower has been used for such varied scientific purposes as the study of the changing amount of electricity in the air from day to day, experiments on the speed of falling bodies meeting with air resistance; the first unsuccessful experiments in wireless telegraphy between the tower and a near-by building in Paris, the study of the sun's light conducted by M. J. Janssen, noted astronomer; and even a study of the physiological effects upon human beings ascending the tower.

Counting noses. This remarkable machine automatically tabulates the information on census cards after they have been sorted mechanically into various groups.

First

Scientific Census Will Put America Under the Microscope

By ALFRED P. RECK

WITH the taking, next year, of the fifteenth decennial census of the population of the United States the Government will tackle the greatest piece of scientific research work along statistical lines ever undertaken.

Since the first census was collected in 1790, the gathering of information every ten years has been concerned mainly with the number of citizens, their national, racial and religious antecedents, and their occupations.

But now the scope of the already enormous task has been vastly extended. In the comprehensive census of 1930, the country will be combed also for data relating to commercial distribution, unemployment, agriculture, manufacture, and many other phases of the national life. Not only will the latest scientific equipment be employed in the survey, but the methods to be pursued will be those suggested by experts in scientific research.

The results of this gigantic study are bound to shape the future activities of the United States and to influence the lives of every man, woman, and child. Not only will the figures gathered by the Census Bureau be used as a guide for future legislation regulating immigration, naturalization, sanitation, and other subjects, but they may also revolutionize business and industrial methods, especially those of production and marketing, and may even form the basis for new military plans.

The machinery to be used in compiling this tremendous mass of facts represents the last word in scientific ingenuity. Robots, operating with almost human intelligence and with greater speed and accuracy than any human, will play an indispensable part. They will do virtually all of the chores except to ask questions of the citizens and check up on vital facts. Without them it would take tens of thousands of persons at least ten years—or until a new census would have to be collected—to assemble and pigeonhole the data.

Of greatest importance to the business and industrial world will be a survey of commercial distribution in the 1930 census. America's system of distributing commodities has been operating blindly. Manufacturers and commercial houses have been largely guessing about established and prospective markets. The result, Department of Commerce officials estimate, has been an annual waste running into billions of dollars. With distribution census figures available, manufacturers and merchants will no longer need to grope in the dark, but can map out their sales campaigns on the basis of figures showing actual conditions.

In 1927, the Department of Commerce, in cooperation with the U. S. Chamber of Commerce, conducted an experimental distribution census in eleven important cities—Baltimore, Md.; Syracuse, N. Y., Providence, R. I., Atlanta, Ga.; Chicago, Ill., Fargo, N. D.; Springfield, Ill., Kansas City, Mo., Denver, Col.; Seattle, Wash., and San Francisco, Calif. The sample was sufficiently large to be significant, for the cities had an aggregate population of more than 6,750,000 and did a total retail business of $4,000,000,000, or about ten percent of the estimated retail trade of the entire United States.

THE results of the survey rudely upset some of the cherished business principles and beliefs of manufacturers. The eleven cities were shown to have 90,000 retail stores. Of this number, forty-seven percent reported less than $10,000 gross sales a year. And half of the forty-seven percent averaged only $83 a week. These findings showed manufacturers for the

When specific information, such as nationality or occupation, is desired of a given population group, the census cards are put through this automatic machine which proceeds to sort them accordingly.

first time that they could not afford to pay salaries and expenses to salesmen calling on retail stores with such a small volume of business. The wealth of facts and figures resulting from this study pointed with amazing clarity to good and bad markets.

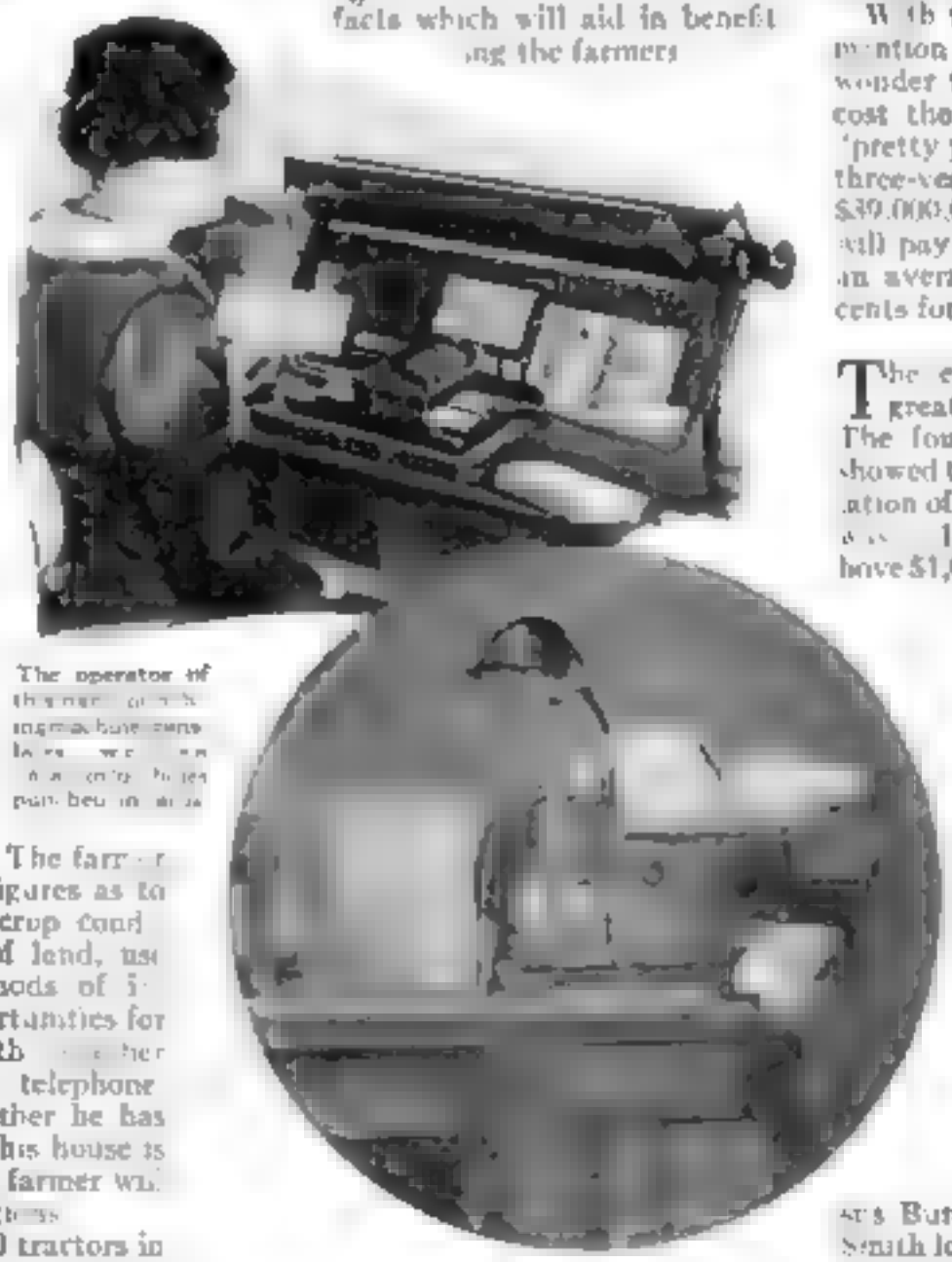
The 1930 distribution census for the entire country unquestionably will do the same, bringing drastic changes in the present system of distribution. Old markets may be discarded and new ones opened.

Moreover, for the first time in history, the federal Government will attempt to make an accurate check on the number of persons without work. During the last presidential campaign, unemployment figures varied according to the political beliefs of the person presenting them. Some said the number was as high as 4,000,000; others put the figure at only 1,000,000. Apparently, no one really knew. Now, the Census Bureau, at the instigation of Congress, is going to find out. The result may mean important legislation or increased activity in public building programs.

The census of agriculture will require the counting of some 6,500,000 farms. The farmer will be asked for facts and figures as to acreage planted, crops and crop conditions, livestock, ownership of land, use of modern machinery, methods of increasing production, his opportunities for recreation and rest, his health whether his house is furnished with telephone electric light, and radio, whether he has an automobile, and whether his house is piped for water. In all, each farmer will be asked more than 300 questions.

In 1920, there were 246,000 tractors in use on farms; five years later, 586,000 were reported, an increase of 138 percent. The 1925 agriculture census showed 284,000 radio sets on farms. This figure undoubtedly will be more than doubled in the 1930 census.

On the 6,500,000 farms in the United States live from 26,000,000 to 28,000,000 people, about one fourth of the nation's population. The economic status of this great body of people who labor to feed the country is of vital concern, and in this connection it is the purpose of the agriculture census to determine facts which will aid in benefiting the farmers.



The operator of this machine controls the ingenious but simple mechanism by means of which punched cards are sorted into groups

Automatic-feeding punching machine does the work of five hand punchers, handling 600 cards a minute.

The census of manufactures will cover production for 1929. The Bureau will try to learn just how much of every known product, from airplanes to aprons, and from pianos to piccolos, were manufactured. It will also determine output per wage earner, wages paid, increase in use of power-driven machinery and in combined horsepower in the nation's factories, as well as many related facts.

The new mechanical equipment acquired by the Government will immeasurably lighten the labor of classifying the harvest to be brought into Washington, D. C., by the census takers. Even so, an office force of about 6,000 employees will be busy for three years or more at the work of tabulation, while 100,000 field men will be required to interview the inhabitants of every part of the country.

At the Census Bureau, expert mechanicians have been preparing the intricate machines that will start humming after the New Year. Among them is a new automatic "gang puncher," which takes the place of five hand punching operators in preparing the census cards for tabulation. Completing four jobs at one time, it handles the cards containing census information at the rate of 600 a minute. Twelve of these machines are being built by the Bureau's mechanical force. In addition, eleven high-speed assorters will work in connection with twenty-six that were used in the 1920 count. The new assorters handle the cards at the rate of 370 a minute—about seventy a minute faster than the old type. Then there are ten new tabulators, to be used with twenty-eight previously in operation.

With this expensive equipment, not to mention the enormous pay roll, it is small wonder that the 1930 census is going to cost the people of the United States a "pretty penny." It is calculated that the three-year job will cost, in all, about $39,000,000. This means that each citizen will pay indirectly, in the form of taxes, an average of a little more than thirty cents for the census.

The expense of taking a census has greatly increased through the years. The fourteenth census, in 1920, which showed that the United States had a population of 105,710,620, cost $25,117,000. It was 1850 that the cost first mounted above $1,000,000. Ten years previously, the expense of counting America's 17,069,453 inhabitants had been $833,370. And the first census ever taken, that of 1790, when the United States had a population of less than 4,000,000, cost a mere $44,377.28.

The involved census-taking procedure, reduced to its simplest terms, may be explained as follows:

When John Smith tells a field worker that he is a farmer, married, a native of the State of Kansas, white and fifty years old, the information is transcribed on a written form. This is sent to the Census Bureau in Washington. Here, John Smith loses his individuality and becomes a cardboard slip, six inches long and three inches wide, dis- (Continued on page 160)

New Air Records and Inventions

In an unusual parachute jumping spectacle, six men leaped from these bombing planes at the same time, above Hendon air field, near London, England. The camera clicked as the parachutes opened—two from each plane. All landed safely

First classroom dirigible the *Mayflower* new nonrigid ship built by the Goodyear Zeppelin Corporation arrives at the Massachusetts Institute of Technology Cambridge Mass to be used in experiments in aerial navigation in fog and radio communication.

Right Accepting the *Mayflower* Dr Stratton president of the Massachusetts Institute of Technology standing in foreground shakes hands with Paul W Litchfield president of Goodyear company.

This new aviation beacon called the largest in the world has been installed at the Municipal Airport, Long Beach Calif Light from its neon tubes is visible to flyers seventy five miles away A flashing device signals to pilots, in code, the airport's location.

What most spectators never see—a glimpse behind the "dock" at the Naval Air Station, Lakehurst N J America s port for the biggest dirigibles. Whenever an airship lands or departs, as on the tops of the *Los Angeles* and *Graf Zeppelin* pictured men of the station's landing crew are called upon to make elaborate preparations. In this picture they are getting the ropes ready for the job of docking a dirigible at the end of one of its long trips.

Two British planes of the latest design offer a strange contrast in size Under the right wing of the larger craft is seen nestling one of the smallest airplanes that has ever been built so small, in fact that it has been termed a "motorcycle of the air." An unusual feature of the large ship is the passenger cockpit in front of the engine.

Shattering the World's Duration Mark—Improved Weapons for Aerial Warfare—Planning a High-Flying Ocean Plane Marvels of Night Photography—Latest Feats of Motorless Flight

THE once imaginary spectacle of a man getting into an airplane, saying to those on the field, "I'll be down two weeks from next Tuesday," and soaring aloft is today a reality. Of late, one endurance record after another has been shattered, culminating, at this writing, in a mark of seventeen and one-half days in the air.

In seven months previous to this record, four crews of American aviators, in as many different planes, had taken turns at boosting what is now recognized officially as the "world's duration record while refueling in the air." Before that it had been held by Belgium, where, late in 1927, two pilots had flown for ninety hours while receiving through a hose fuel supplies from another plane.

Early this year five United States Army aviators in the tri-motored plane *Question Mark* flew for more than 150 hours over Los Angeles, Calif. Five months later R. L. Robbins and James Kelly, two comparatively inexperienced pilots, flew a second-hand monoplane for 172 hours over Fort Worth, Texas. The record kept growing. Byron K. Newcomb and Roy L. Mitchell extended it to 174 hours at Cleveland, O. and Loren W. Mendell and Roland B. Reinhart raised it again at Culver City, Calif. to 246 hours—ten days and a quarter—in the air. Now Dale Jackson and Forrest O'Brine, at St. Louis, Mo., have just given an astonishing exhibition of human and mechanical endurance by flying for 420 hours. Even as this is written, others are in the air to attempt to beat them.

One of the new American transport planes, the twin-motor twenty-passenger Curtiss *Condor* on a recent trial flight over Long Island, N. Y. With each motor developing 635 horsepower, it is capable of a speed of 130 miles an hour. It is equipped with radio.

Anchorage for Seadrome

HALFWAY between New York and Bermuda, a submerged plateau that rises far above the rest of the ocean floor is expected to aid in establishing a floating island for sea-voyaging planes. This plateau, mapped recently by a Navy survey, will make it possible to use anchor cables of reasonably short length to keep the artificial island from drifting.

Actual experiments are planned for next spring in the use of the seadrome, invented by Edward R. Armstrong, Delaware engineer. It is to be a veritable floating landing field in mid-ocean for New York-to-Bermuda planes. Steel work for the platform is being constructed at Chester, Pa., and the island is to be assembled by a shipbuilding concern at Cape May, N. J. Three-mile cables will terminate in mushroom anchors to keep it from drifting. Should the experiments prove successful, other seadromes may be built for transatlantic air lines.

To Berlin in Six Hours?

A HIGH-FLYING airplane that might fly, at an altitude of eight miles, between Berlin and New York in six hours is the invention claimed by H. G. Perl, young German engineer. Shaped like a Zeppelin, the duralumin machine would have a passenger cabin in which a pump would maintain normal air pressure and make comfortable breathing possible in the thin upper air.

At such a height, owing to the lack of air resistance, Perl calculates that his machine should be able to attain a speed of 650 to 750 miles an hour. Its wings would be shaped like those of a flying fish, and there would be small fins on the tail. An internal combustion engine of only eighty-five horsepower would drive the craft, its hot exhaust furnishing cabin warmth in the Arctic cold of the high altitudes. A patent has just been granted Perl on his invention, and he promises that within four months he will have such a machine ready for a trial flight.

Although there is no guarantee that Perl will succeed in his experiment, the idea of superspeed airplanes flying at great heights has been endorsed by many experts as feasible in theory. It is well known that at eight to fifteen miles above the earth a pilot could laugh at rain, fog, sleet, and electric storms; they never reach such heights. Instead of erratic winds, regular rapid wind currents are believed to exist at various upper levels. These a high-flyer might use to advantage by rising into a favoring current. In the event of a forced landing at sea, he might be able to glide 300 miles with a dead engine before landing, giving him sufficient time to locate a nearby ship by radio, and distance enough to land alongside it. Perhaps eventually the present airplane altitude record of 42,000 feet made by the oxygen-breathing German, Neunhofer, will become a regular airplane height for long-distance flights of passenger aircraft.

A Camera "Machine Gun"

A MACHINE gun that shoots pictures instead of bullets is the newest in military air training. The instrument resembles a standard machine gun in appearance, size and weight; but when the trigger is pressed the "gun" fires no bullet. Instead, it takes a small photograph that shows just where the bullet would have struck on an enemy plane.

Armed with these weapons, airmen may go aloft and engage in a mimic battle. Through an automatic device, the resulting pictures bear an imprint showing the exact time at which each was taken. Thus the winner of a "battle," the one who first hit a vulnerable spot of the other plane, may be determined.

Wind Vane for Night Flyers

A NIGHT wind vane that flashes the direction of the breeze in electric lights to incoming pilots is the invention of R. C. Jackson, Oakland, Calif., electrical engineer. In the exact center of the airport is arranged a group of glass-covered trenches radiating outward like the spokes of a wheel, each containing electric lights. These are connected by electric wire to an ordinary wind vane on the field and are so arranged that when the vane points north, only the north-pointing trench on the ground is illuminated. As the vane turns, other trenches instead flash into brilliance.

Since a pilot should know the wind direction to make a good landing, the device may prove a boon to night flyers.

Sharpshooting with Bombs

A NEW bomb-aiming device that enables an airplane flying 1,500 feet high to drop a 100-pound bomb down the smokestack of an enemy battleship has just been purchased by the United States War Department. Army officials say that such a projectile would do as

much damage as a two-ton charge dropped on the ship's deck from a bombing plane, since the smaller projectile would explode in the ship's most vital part.

The device that aims bombs with such astounding accuracy is said to be "as intricate as a chain of Swiss watches." It is a bomb sight that takes into account the speed of airplane and ship, the movement of the air, and "air pockets." Several are to be manufactured immediately, at a cost of $28,000 each. The invention is believed to be the first of its kind in the world.

Parachutes Tested by Monkeys

NOT human beings, but monkeys, risk their lives to try out new types of parachutes in Japan. According to George M. Lord, traffic official of a western United States air line, the animals are trained to pull the rip-cord that opens the parachute and are then tossed from an airplane in full flight. If the monkey lands safely, the parachute is considered safe for human use.

Frequent casualties among the monkeys attest the wisdom of this procedure. Dummies could not be used, for the cord that unfurls the parachute must be pulled during the descent.

Aerial Photos by Night

A DEMONSTRATION of the United States Army Air Corps' latest wonder, night photographs taken by flashlight from the air, recently created a war scare among the natives of Panama. Powerful charges of flashlight powder exploded in the air, and their blinding flashes convinced the populace that an enemy was dropping bombs, even Army officials on the ground, not notified of the tests, were alarmed. Actually Dr. S. M. Burka, of the Air Corps' Materiel Division, had obtained excellent photographs of the Canal Zone area.

Taking a flashlight photo of a city from the air is not a new idea. Important experiments along this line were commenced at Dayton, O., and Rochester, N. Y., nearly four years ago by the Army Engineering Division. Only recently, however, has the process been so perfected as to make it possible for newspapers to obtain photographs of flood or storm disasters without waiting for daylight, or for military strategists to have before them in a few minutes night photos of the enemy's movements snapped from speeding planes. Brave men risked their lives to make the feat possible.

One night during the first weeks of the tests, Lieutenant George W. Goddard, United States Air Corps—inventor of the first aerial flashlight apparatus—took the air with Dr. Burka in an observation plane over Rochester, N. Y. Fastened beneath the fuselage was a sort of aerial torpedo, a glider to be released in flight and towed at the end of a long cable. It was filled to the brim with flashlight powder—sixty pounds of high explosive. The signal was given, the torpedo released. Then, with about fifty feet of cable out, the mechanism jammed. It was impossible either to pay out more cable or to cut the deadly trailer loose. Just as the two men were preparing to jump for their lives the glider swooped past the tail of the plane, broke loose, and dived to earth without exploding—much to the surprise and relief of them both.

On another occasion Goddard was not so lucky. By this time, free dropping flashlight bombs had been substituted for powder-filled gliders. With four other men, Goddard made a night flight over Dayton to try out the new plan. The camera was made ready, and a flashlight bomb released. Something apparently went wrong with the time fuse, for the bomb was only fifteen feet beneath the tail of the plane when it exploded prematurely. For an instant the plane stood on one wing, veering crazily. Its occupants were stunned into semi-consciousness. Then the pilot, Lieutenant Gene Batten, regained his senses and attempted to right it. Although the controls were jammed, he managed an emergency landing. All escaped with their lives by a miracle. The entire rear floor of the fuselage was torn away, the tail twisted, and wood members in the nose and wings were shattered.

Today the process has been so perfected that an excellent flashlight photo of Fort Leavenworth Prison, Kansas, taken from a low-flying plane at 9:48 P.M., was developed, printed, and rushed by telephoto to military officials at Chicago, New York, and San Francisco, reaching the last city at 10:30—less than an hour after the camera shutter had clicked. Other pictures have been taken of Rochester and of Dayton in which even automobiles parked on the streets are clearly visible.

With passenger planes taking off rain or shine, an innovation at the Grand Central Air Terminal, Glendale, Calif., is this inclosed corridor of steel, leading from the terminal waiting room to the outgoing plane. The last third of the tunnel telescopes in or out to reach the doorway of the plane.

Women Aces Recognized

THE flying achievements of women assume new importance with the announcement that the Fédération Aéronautique Internationale, world governing body in aeronautics, has decided to recognize and classify them as separate records. The decision ends a long battle by women flyers to obtain official sanction for their feats. It will automatically award to Americans the feminine world records for endurance, altitude, and speed, on the basis of their past performances. The expected recipients are, at this writing, Miss Elinor Smith with her endurance record of twenty-six hours; and Mrs. Louise McPhetridge Thaden, who piloted a plane at 156 miles an hour and on another occasion soared to a height of 20,270 feet.

On another page are pictured some of the women who have achieved prominence in the air. All have demonstrated a degree of flying skill of which any man might be proud. Yet not many years ago the spectacle of a woman taking to wings was considered extraordinary. Only a few daring pioneers paved the way for later triumphs of their sex. A Flemish girl, Mlle. P. van Pottelsberghe of Ghent, riding beside Henry Farman in his old Voisin biplane as early as 1908, won the distinction of being the first woman to fly. But it remained for the Baroness Raymonde de Laroche, French sports woman and automobilist, to be the first woman to pilot a plane. After a few weeks of lessons, in the fall of 1909, she took her Voisin plane into the air at Mourmelon. She participated in an air contest in Egypt in February, 1910, in which, it was announced, the aviators would "fly around the Sphinx, if possible," and her twelve-mile flight won her a pilot's license from the Aero Club of France. Meanwhile an Irish girl, Miss Lilian S. Bland, constructed a flying machine entirely by herself.

Among the first women in the United States to pilot planes were Miss Harriet Quimby, a magazine writer, who, in 1912, was the first woman to fly the English Channel; Miss Katherine Stinson, called the first woman stunt flyer in the United States, who taught her famous brother, "Eddie," to fly; and Ruth Law, who made the first loop-the-loop in 1915.

Two New Glider Records

SOARING nearly two miles above the earth with no motor to aid him, Robert Kronfeld, Vienna glider pilot, recently set a new world's record for altitude in a motorless plane at Gersfeld, Germany. His mark of 9,780 feet exceeded by more than half a mile the previous record of Max Kegel, a German glider expert.

Another world's record went to Kronfeld when he glided across country for a distance mark of 102 miles.

Recently the art of gliding has been improved by what is known as "cloud flying." Formerly pilots kept their gliders aloft by taking advantage of rising currents of air along hillsides, but now the rising air streams beneath cumulus clouds are also utilized.

Women Flyers Who Have Made Their Mark

Two famous ocean flyers · Ruth Elder left and Amelia Earhart. Miss Elder now is engaged in motion pictures and Miss Earhart is encouraging women to enter aviation.

Mrs. Mary C. Alexander, mother of two grown children, who is learning to fly at the Roosevelt Flying School, N. Y. She is planning to sell airplanes in her home state of Virginia.

Elinor Smith, U. S. endurance record holder. Above: Gladys O Donnell.

Bobbie Trout, the only woman who holds the job of chief test pilot, and formerly holder of solo endurance flight record.

Marjorie Crawford, who is making plans to beat the women's endurance record of Elinor Smith, has been flying since she was fifteen.

They call Florence Lowe Barnes, at left California's "Tomboy of the Air." She is the high flying wife of a clergyman.

Ruth Nichols, New York society girl and airplane pilot. As an aviation company executive she has made a notable success of commercial aviation. At this writing she is on a 12,000-mile tour to organize aviation country clubs.

Marvel Crosson, once holder of the women's altitude flying record, who was killed when her plane crashed in Arizona during the women's air derby. She had been flying since 1923, and was a skilled pilot.

Lady Mary Heath (with flowers), England's famous woman flyer, and first to fly the length of Africa, nonchalantly talking over plans for the First National Women's Air Derby with Sarah Wetzender.

New Gale Machine Tests Planes

A HURRICANE that could knock a man flat will soon rush through a tube ten feet in diameter, which, when completed soon at Pasadena, Calif., will form one of the finest aeronautical wind tunnels in the world. Within it a set of vanes that looks vaguely like a giant automobile radiator will control a man made gale of 120 miles an hour, produced by a four bladed propeller with a streamlined electric motor. Experts of the Daniel Guggenheim School of Aeronautics at the California Institute of Technology will use the outfit to try out new plane designs before the planes are actually flown.

Instruments which record velocity of the air stream in the new ten-foot wind tunnel at the California Institute of Technology. Dr. Arthur L. Klein, head of the aeronautical research staff, is at right.

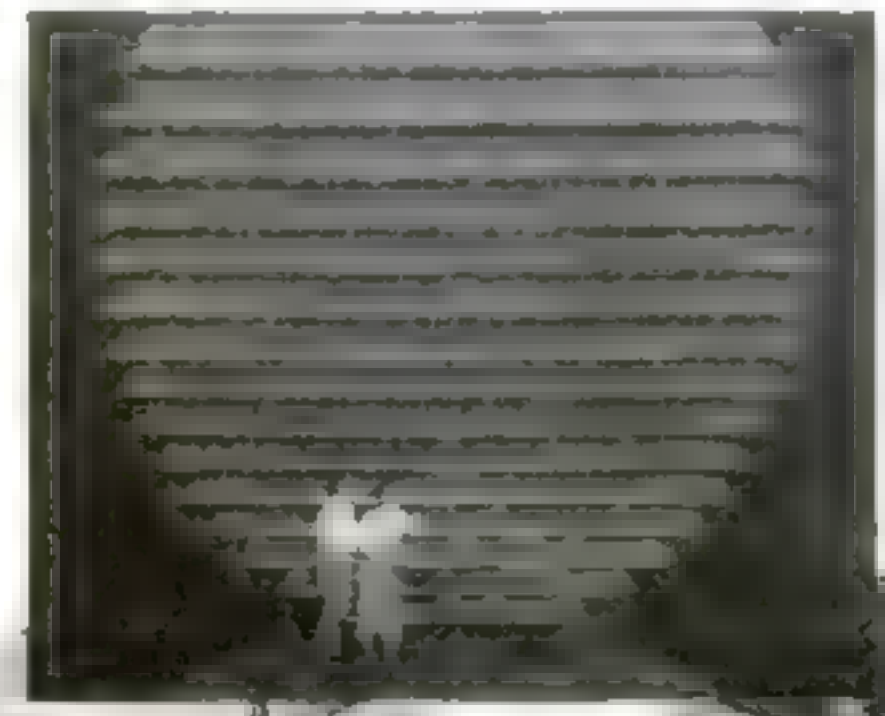
Testing inexpensive models of new airplanes instead of the planes themselves, to see whether they will fly, is a development made possible by the wind tunnel, and dozens of them are in use in the United States today. To build a two or three foot model of a flying machine of radically new design may cost from $100 to $1,000. Artificial air currents in a wind tunnel then speedily reveal its faults and merits—whether it is tail heavy, likely to spin, or safe for the novice to fly. Wires that suspend the model in the tunnel, attached to sensitive balance

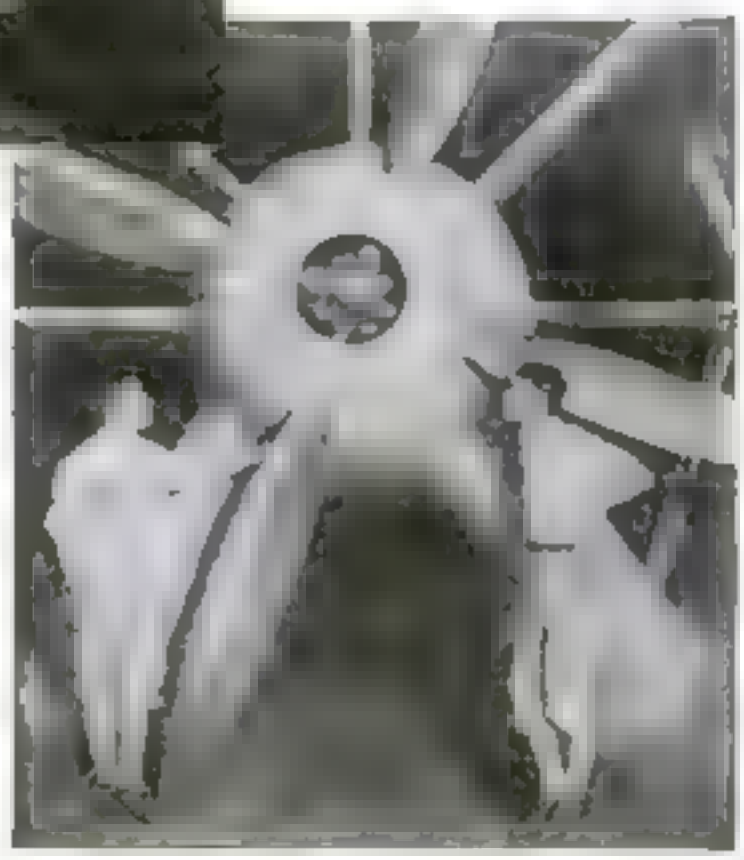
a plane, he can try it out with

ships have been tried out for streamlining in this way. The average automobile, at a speed of thirty miles an hour, expends about four horsepower to overcome air resistance alone, since this may be reduced by streamlining, wind tunnel tests on car designs have been carried out extensively in Europe where the high price of gasoline encourages economy of fuel. In the airplane industry the tunnels are of service not only in developing improved commercial models of planes, but also in experiments to improve the airplane accessories.

Recently the National Advisory Committee for Aeronautics announced what was hailed as the greatest single contribution to airplane efficiency since the war, a curious bow shaped cowling that fitted over the front of a plane's air cooled engine and, by decreasing wind resistance, boosted the speed of a plane by as much as twenty miles an hour. This invention was born in the Committee's giant twenty foot wind tunnel at Langley Field, Va., built at a cost of $5,500,000.

Here, where gales of 110 miles an hour could be produced at will, full-sized motors with their different cowlings were mounted in turn on a cabin fuselage and set up at the mouth of the tunnel. Engineers measured the power of the motors with a dynamometer, a thrust measuring instrument, and checked the temperature of the cylinders with thermocouples, high temperature electric thermometers, to be sure that the engines were properly cooled. They were surprised to discover that a cowling almost complete





Building the new wind tunnel. [illegible] the man standing with [illegible]. Right. The four-blade [illegible] in which models of newly designed machines are put to exhaustive tests.

One of the machines for freezing fish quickly to preserve their freshness. The boned or "filleted" fish, placed on great trays, are carried over freezing brine.

Fish Kept Fresh 1,500 Miles from Sea by New Scientific Refrigeration

By ROBERT E. MARTIN

"AND a package of haddock," a Kansas housewife tells her grocer. He hands her a sealed box, faintly cool to the touch. In the kitchen, she drops its contents in a frying pan. It is a fish fresh from Atlantic waters, now for the first time available to her through a new process of quick freezing. Frost still covers it after its 1,500-mile journey by refrigerator car and fast motor truck.

Last year more than 30,000 tons of fish were placed in trade-marked packages and sold like any grocery. Much of this was frozen, enough to make it the first successful tryout of the quick freezing process which other industries likewise are exploiting in new commercial applications. Sausages and clams, frozen through and through, reach distant destinations with the same wholesome, appetizing flavor they had at the start. Even rabbit meat, roasting ducks, and sirloin steaks have appeared, quick-frozen, in package form.

Only a revolution in the "cold storage" methods of shipping could have made such long-distance shipments seem possible. That revolution is taking place. There is the recent discovery of a way to freeze meats and fish without impairing their food value. Within the last few months has come the invention of a refrigerator freight car that maintains automatically, in its iceless insides, the temperature of a howling January gale for uninterrupted hours. Motor trucks with efficient built-in refrigerators, sub-zero cabinets for retail stores, and refrigerated packages for mail delivery complete the new system of transporting "perishable" food in a preserved condition.

All this is so new that even the men responsible for keeping Americans' tables stocked with fresh food all the year around are only beginning to realize what it means to them. It may make a lot of difference in the way that they handle the 3,600,000,000 pounds of food that goes into cold storage in the United States during the peak months—enough to feed one American family for the next 800,000 years. The eggs in cold storage, alone, make such an imposing total that it would take a single hen 36,000,000 years to lay them all. The supply of stored fish is so great that a fisherman would have to work 1,500 years to catch them all, even if he could

An expert of the Department of Agriculture determining the freezing point of a potato. He found that the vegetable freezes at about 26 degrees F

average ten fifteen-pounders a day. To keep this enormous mass of food fit and fresh from the time it is placed in cold storage until it reaches the dinner table is a difficult engineering problem of the first order

"QUICK-FREEZING" has made possible the delivery of fresh fish in packages. It is the recently developed science of freezing animal tissue without injury or loss of their juices. Other ways of freezing fish had been tried, but they were failures. Until fish were first kept on ice in 1825 virtually no new method of preserving them had been used since the salt treatment of Biblical times. The Pilgrim Fathers, when they landed in Massachusetts, were still using salt. Some of their descendants continue to do so. The first serious experiments in freezing fish commenced hardly more than thirty years ago, when iceless refrigerating plants first began using ammonia to produce a colder cold than ice. The results were unsatisfactory. Frozen fish dried out, lost weight, turned yellow or sour.

Dr. Harden F. Taylor, appointed by the late President Wilson to the United States Bureau of Fisheries to find ways of increasing food supply, set out to find the reason. He discovered it under the microscope. Large, jagged ice crystals had punctured the flesh of the frozen fish. The flavor and nutritive substances in the cells had leaked out, allowing the entrance of bacteria that would spoil the fish.

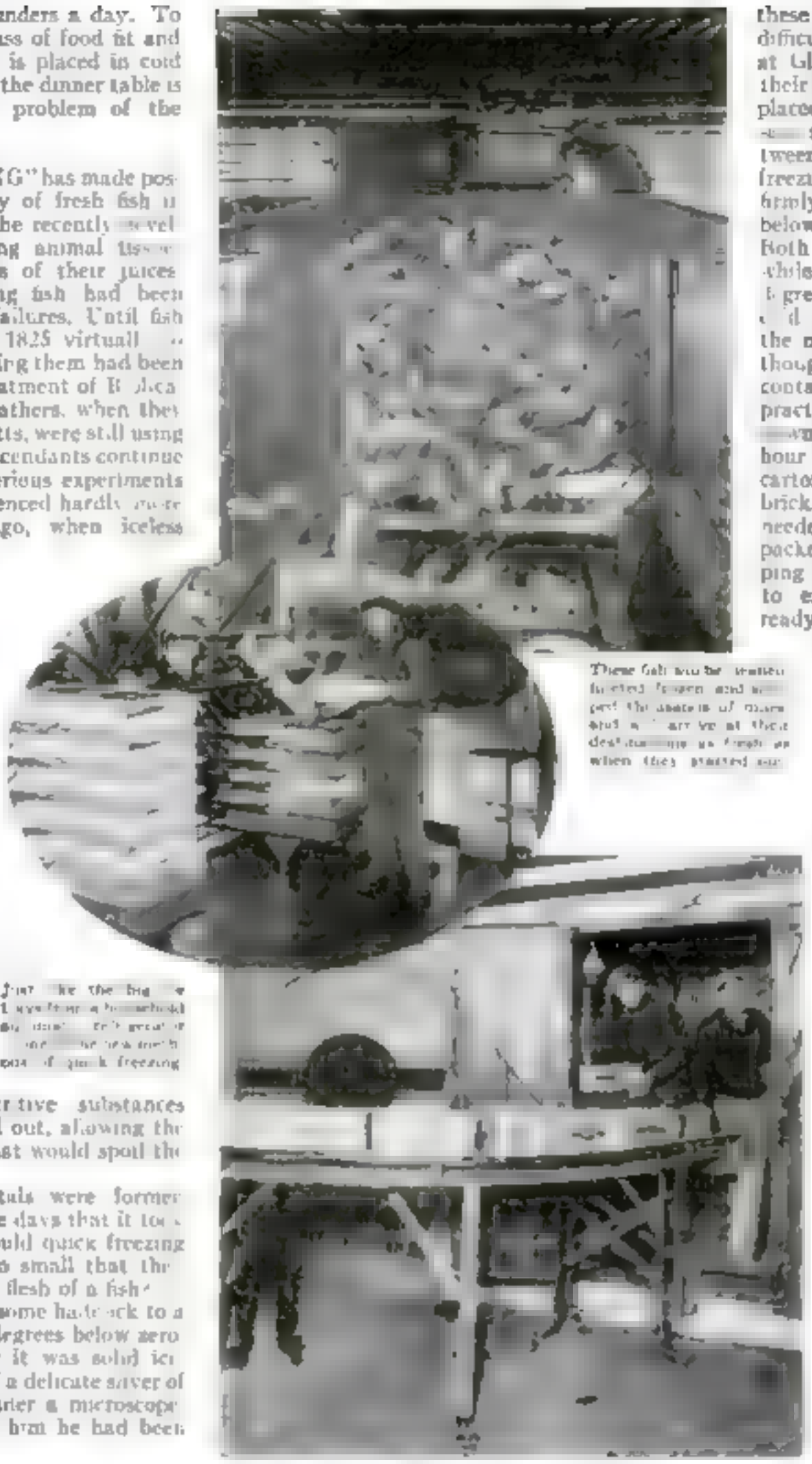
The large ice crystals were formed during the two or three days that it took to freeze the fish. Would quick freezing produce ice crystals so small that they wouldn't puncture the flesh of a fish?

Dr. Taylor exposed some haddock to a temperature of forty degrees below zero. In less than an hour it was solid ice. Carefully he shaved off a delicate sliver of flesh and placed it under a microscope. Tiny ice crystals told him he had been successful.

NOW for a practical try-out. The haddock were quick-frozen, dipped in a pan of water to give them a protective shell of ice, and placed in storage. Six months passed. Then the haddock were removed and thawed out.

"We looked at their cells," says Dr. Taylor. "Almost perfect! We weighed them to see how much moisture had escaped. Practically none! We cooked and ate some of the fish. Delicious!"

Today the idea of congealing fish almost instantaneously to preserve them with tiny ice crystals is applied commercially in factories that dot the Atlantic coast from Nova Scotia to Florida. One such plant, at Halifax, N. S., freezes a ton of fish every two hours.



Not a moment is lost. Frozen fish, packed in cartons, are conveyed quickly into the refrigerator cars, which transport them.

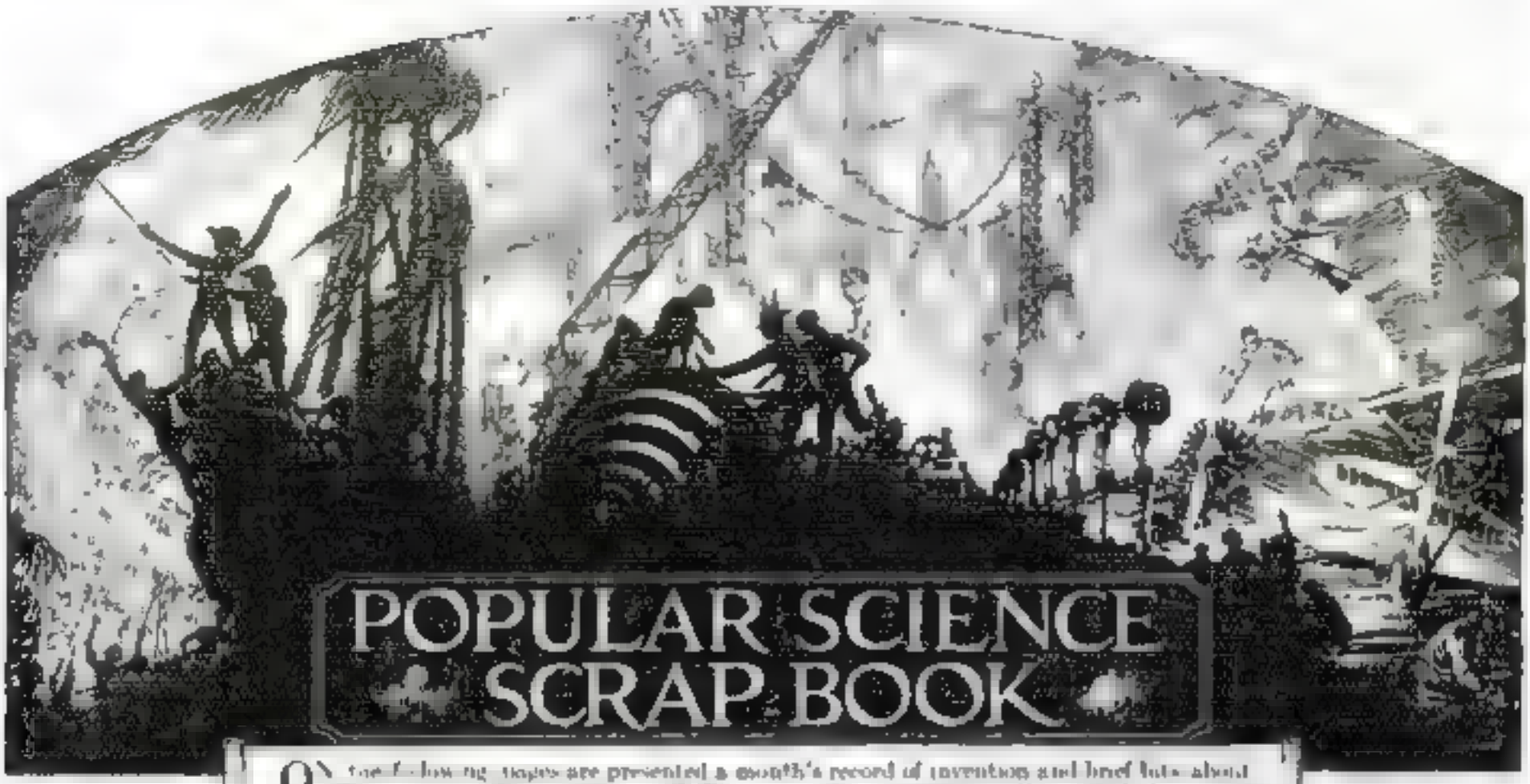
But adapting the laboratory process to commercial use has proved less simple in fact than in theory. A fish's body is mostly water—from seventy-five to eighty percent, to be exact. To freeze a ton of fish, then, three quarters of a ton of water at room temperature has to be turned to ice—a process that requires the removal of about 280,000 B. t. u., or heat units. Otherwise stated, this feat is comparable to extracting heat from a thousand-pound chunk of glowing, red-hot iron until it is cool enough for a person to lay his hand on it anywhere with comfort.

Ingenious machines are at work in these factories to accomplish the difficult operation. In a plant at Gloucester, Mass., fish with their fins and bones removed are placed in their final packages and [illegible] rolling, carton and all, between two wide metal belts in a freezing tunnel. One belt presses firmly against the package from below and the other from above. Both belts are sprayed meanwhile with brine at forty-five degrees below zero, the searing cold being transferred through the metal to the package. Although the brine cannot come in contact with the fish, there is practically no air space to slow down the freezing. After an hour in the freezing tunnel the carton of fish emerges stiff as a brick. No more refrigeration is needed, and the cartons are packed into heat-insulated shipping cases, lined with material to exclude warmth, and are ready to be dispatched to their destination. Lately not only fish, but also clams and sausages, have been quick-frozen by the same method.

IN ANOTHER process used by a Groton, Conn., factory, boned or "filleted" fish are laid, unpacked, on wide aluminum plates that travel around an endless oval track in a freezing room. A trough beneath the plates is filled with brine at about twenty degrees below zero, in contact with the bottom of the moving plates. By the time a plate has made the circuit of the room, which takes forty minutes, the pink-white fish are frozen hard as stone. Operators with gloved hands feed the chilly objects into a wrapping and sealing machine that bundles them up in waxed paper and puts them in a package for shipment. Haddock, cod, sole, and other fish are treated in this way.

AN ICELESS refrigerator car, made possible by a new refrigerating system without moving parts, transports such products as these to great distances. An observer looking for the great pumps and compressors that ordinarily go with iceless cold storage plants would be surprised at their absence. Instead, the heat of a small gas flame and a remarkable substance known as "silica gel" keep the refrigerating fluid circulating through coils within the car.

This silica gel, a hard, glassy material that looks like shiny sand, is one of the most porous materials known to science. When cool, it absorbs enormous quantities of the liquid that chills the pipes; when heated, it drives (Continued on page 158)



On the following pages are presented a month's record of inventions and brief bits about the new, interesting and unusual things people are doing in all parts of the world

Young Astronomers Run High School Observatory

OVERLOOKING the Golden Gate at San Francisco, California, is an unusual astronomical observatory owned and operated by a high school. The building and its equipment are mounted on the top of the annex of the Galileo High School, which is named after the famous Italian astronomer of the seventeenth century.

The revolving dome surmounts an artistic concrete room in which the amateur astronomers meet for their nocturnal studies. It is entered by an outside stairway leading from the roof of the annex building. As part of their work, the members of the high school class assembled the equipment and mounted the instruments under the direction of their astronomy instructor, Harry Raphael.

THE telescope, mounted within the twenty-one-foot dome, is of the refractor type. That is, it has a magnifying lens instead of a mirror within the barrel. Through its five-and-one-half-inch lens familiar stars may be studied closely while intricate electric clockwork mechanism within the base of the telescope circles the large "spyglass," synchronizing its movement with that of the heavenly bodies being observed.

Besides the large telescope, the equipment includes a second smaller instrument, as well as sextants and other apparatus for supplementing the textbook work of the students with first hand observations.

Funds to purchase the telescopes and mountings were raised by the high school students themselves.

The new equipment at San Francisco is but one of several roof-top observatories erected by high schools for the use of embryo American astronomers. Besides, many amateur sky-watchers have built their own home equipment for studying the stars.

A junked automobile helped Leland M. Thurston, a sixteen-year-old Providence R. I., boy, to construct a telescope which he set up in his back yard. The elevating and rotating parts of the instrument were discarded units of the auto. Thurston purchased his reflecting mirror "in the rough" and ground and silvered it himself. A cobweb on the chimney of a neighbor's house appears like a piece of rope, he said, through the homemade instrument.

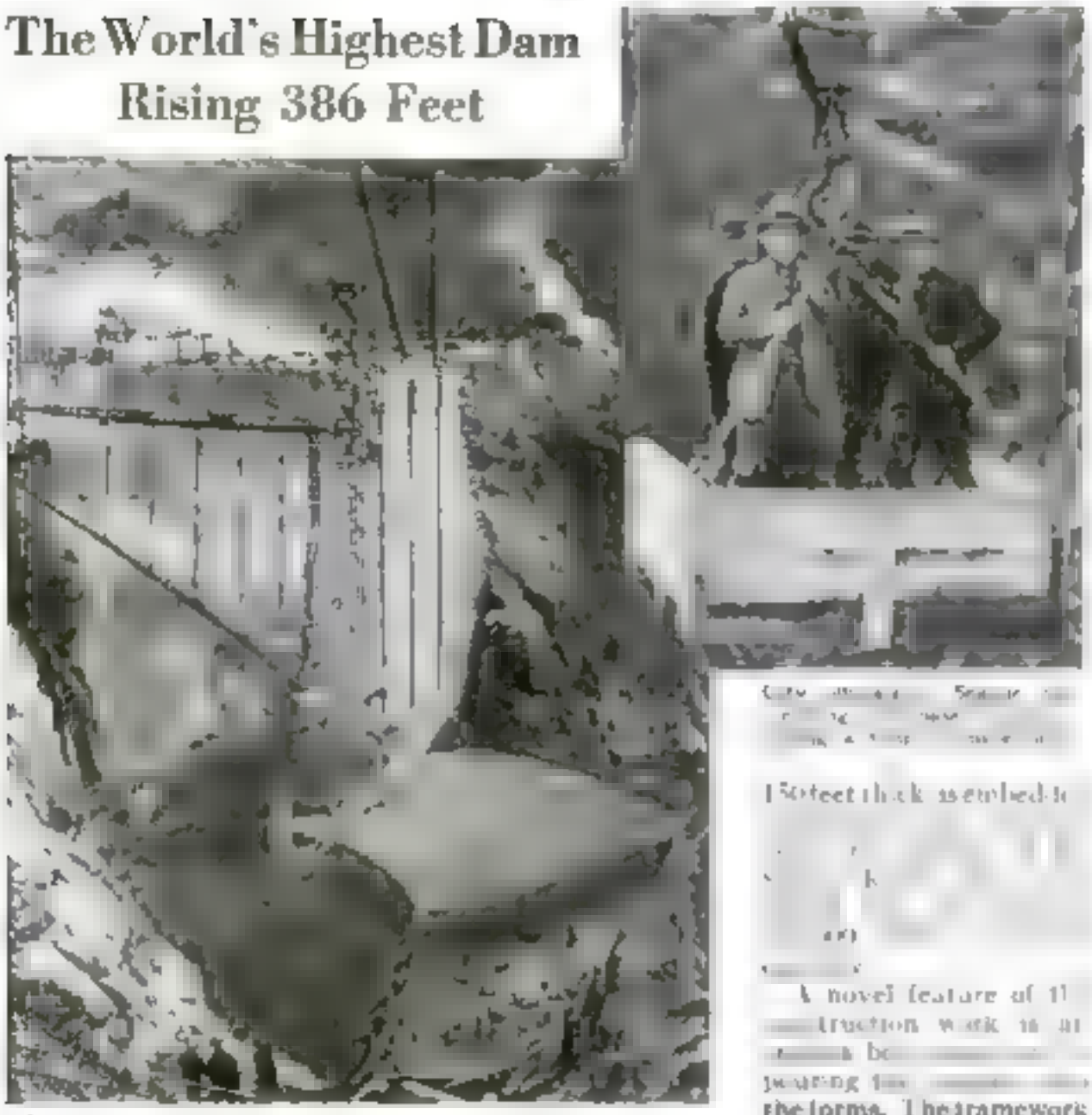
High school students mounting their five-and-one-half inch refractor telescope in the observatory. Electric clockwork mechanism synchronizes it with the movements of the stars.

The observatory on the roof of Galileo High School, San Francisco, and a student using a sextant.

RICHARD WILLIAMS, a fifteen-year-old amateur, of San Jose, Calif., is the youngest member of the American Association of Variable Star Observers. He sends in to the Harvard University Astronomical Division a monthly report of findings with his improvised telescope.

Recently an amateur living near Cape Town, South Africa, discovered a new comet. Officials of the Union Observatory in Cape Town named it the Forbes Comet after its discoverer. In 1927, two other comets, too faint to be seen without the aid of a telescope, were reported within a few days of each other. Both were discovered by amateurs.

The World's Highest Dam Rising 386 Feet



Building the 386-foot Diablo Dam on the Skagit River. An endless belt conveyor pours 1,500 cubic yards of concrete a day

A CONCRETE dam that will be a foot higher than the present record holder, the Pacoima Canyon structure of southern California, described in a recent issue of POPULAR SCIENCE MONTHLY, is being built on the Skagit River in the state of Washington. When completed next spring, it will stand 386 feet high. It will form the heart of a gigantic $30,000,000 hydroelectric project under construction by the city of Seattle.

The new Washington barrier, known as the Diablo Dam, is located on the west slope of the Cascade Range. Its base, [illegible] feet thick, is molded to the forms. The framework on which the belt moves can be swung to any part of the location, and the conveyor pours 1,500 cubic yards of concrete a day.

The mayor and city officials of Seattle recently made the 150-mile trip from the city to inspect the site of construction and observe the progress being made.

The neighboring state of Oregon will eventually eclipse the Diablo Dam with a structure that appears likely to hold the lead for some time. On the Owyhee River, in the eastern part of the state, near the Idaho line, the United States Government is erecting a mighty wall of concrete that will rise 405 feet when finished.

Metals Act Strangely at 458 Below Zero

BY MAINTAINING a temperature of 458.58 degrees F. below zero in a chamber twelve cubic inches in size—nearly that of a half-pint container—Prof. W. H. Keesom, Leyden University physicist, recently paved the way for experiments to reveal new properties of matter. This temperature had been achieved before, but only in a space about the size of a small grape—of one cubic centimeter. With the Dutch expert's new apparatus, instruments may be placed in the chamber for studying the strange manner in which metals and other substances behave when they are subjected to the extreme cold.

It is hard for the human mind to conceive of such frigidity as 458 degrees below zero, when a variation of about 150 degrees spells all the difference between hot summer weather and icy winter. At the lower end of the temperature scale objects behave strangely. The air freezes solid, and a tin cup becomes so brittle that it can be shattered with a hammer into a thousand pieces.

Only eighty-two hundredths of a degree below the temperature of Prof. Keesom's half pint flask lies "absolute zero"—that temperature, never yet attained, at which heat ceases to exist.

Preventive Science Cuts Typhoid Death Rate

THE fight against the invisible typhoid bacillus was marked with increased success last year, the American Medical Association reports. Of eighty-one cities in the United States having populations over 100,000, nine had no typhoid deaths during 1928. One of these, Tacoma, Wash., stood at the foot of the list of Mountain and Pacific states in 1927. Last year, it made a record which none of the other cities has ever equaled. It had no deaths from typhoid or diphtheria during the twelve months.

Preventive inoculation and increased sanitary precautions are the weapons used against the disease. The value of vaccination against typhoid was demonstrated during the war, in the American Army, where it was compulsory.

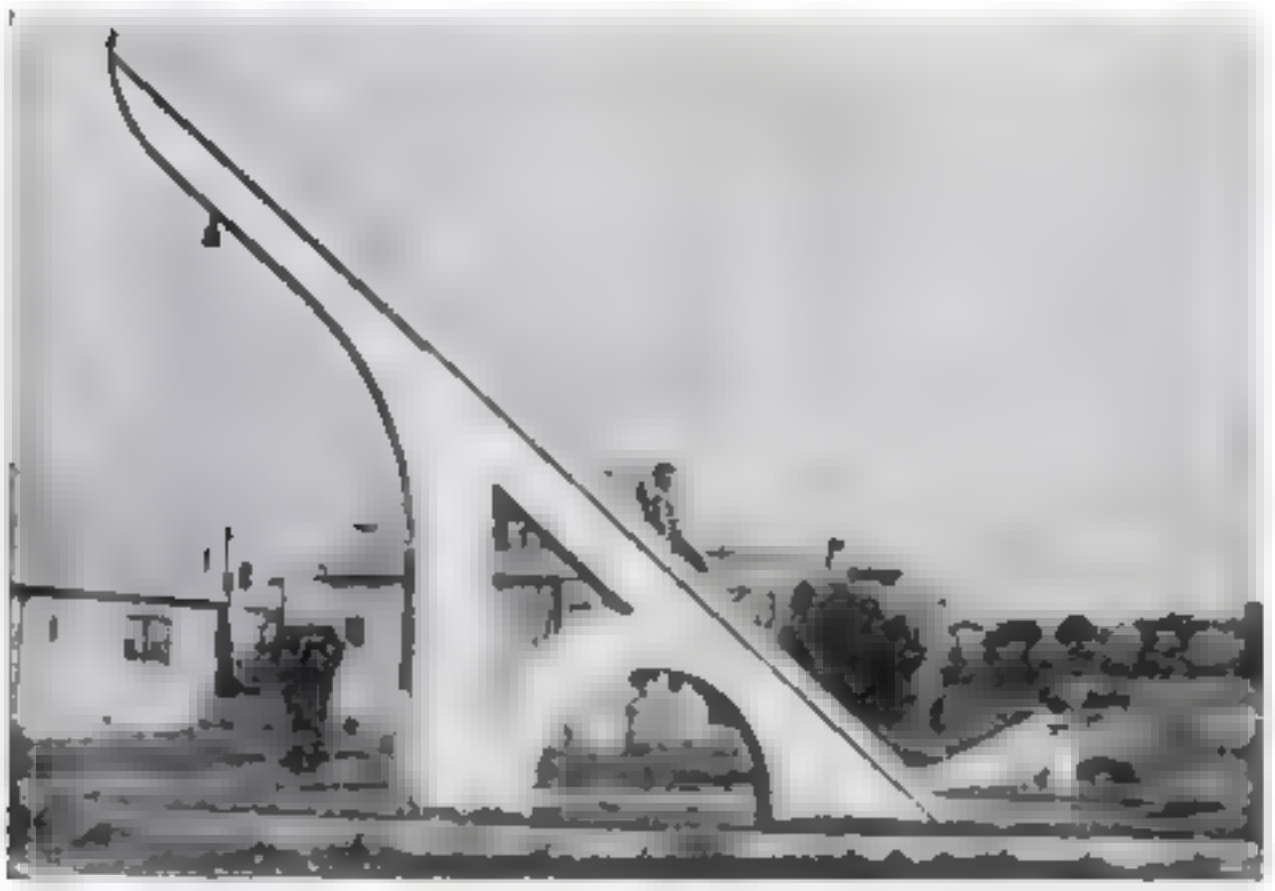
Outboards Drive Racing Sloop through Canal

PROPELLERS of two outboard motors lashed to the sides of the after deck of the *Margaret F IV*, a racing sloop, recently drove it through the Erie Canal. When the owner decided to take the craft from New York City to Detroit, he found the hull was too high for convenient transportation by rail and decided to take it through the canal. As there was no room for tacking in this waterway, it was impossible to make the trip under sail; so a heavy piece of timber was bolted across the after deck and two outboard motors attached to it.

By turning the motors or slowing one down, the unusual boat was steered up the canal, reaching Lake Erie without trouble. This new wrinkle in navigation came shortly after outboard motors had been adopted as regular equipment on barges in an English canal, as related in the August POPULAR SCIENCE MONTHLY.

The racing sloop *Margaret F IV* sails furled, starting her trip up the Erie Canal, driven by two outboard motors at the stern. The motors are attached to a heavy timber bolted across the deck.

Largest Sundial Is a Lamp-Post at Night



Constructed of reinforced concrete, this enormous sundial tells the time in a small park at San Francisco. The electric lamp hanging near the top of the sloping stile illuminates the park after dark.

A SUNDIAL almost as high as a house and said to be the largest in the world, was completed recently in a residential district of San Francisco, Calif. Its sloping stile, which casts a shadow to indicate the time of day, is made of reinforced concrete; and about it circles a curb of concrete to form the dial itself, which is marked with hourly divisions.

More a curiosity and an ornamental structure than an accurate time-recorder, the enormous dial has attracted visitors from all parts of the city. Its upper end has been utilized as a lamp-post, an electric light hanging from it to shed illumination on the small park in which it is located, and children living near by use the sloping face as a slide.

Up until the eighteenth century, when clocks and watches began to be common, sundials were in wide use for telling time. A Babylonian astronomer, Berossus, about 300 B.C., constructed the first sundial of which there is certain knowledge. Four hundred years before this, however, the writer of Isaiah in the Bible referred to the shadow of a sundial but gave no inkling of how the dial was constructed.

Speeding Train Drops Off Cars at Way Stations

EXPRESS trains which literally "fall apart" at full speed to deliver cars and their passengers at small way stations were put into service in England the other day. Coaches destined for minor stops are attached to the rear and detached or "slipped" when their stations are reached, while the train speeds on.

The "slipping" is accomplished through an ingenious uncoupling device. Over the coupling hook fits a sliding bar which is lifted by a lever operated by a "slip-guard" from a compartment at the front of the section to be detached.

As soon as the coupling is broken, the air brakes are automatically applied to the detached section. Naturally, both airbrake and train heating pipe connections are pulled apart, but the air brake pipe on the proceeding express is automatically sealed as are the heating pipes on both sections.

Counts 8,239 in Ant Hill

HOW many ants are there in the average mound?

About ten thousand, according to Prof. E. A. Andrews, of Johns Hopkins University, Baltimore, Md. In one case, Professor Andrews actually counted the ants in a mound and found its galleries inhabited by exactly 8,239 individuals. These insects were ruled by no fewer than eleven queens. The queen ant is not intolerant of her rivals like the queen bee, which kills all young pretenders to her throne unless prevented by the workers.

In previous counts of ant heap populations, the total often has been given as close to 30,000, and sometimes as high as 500,000.

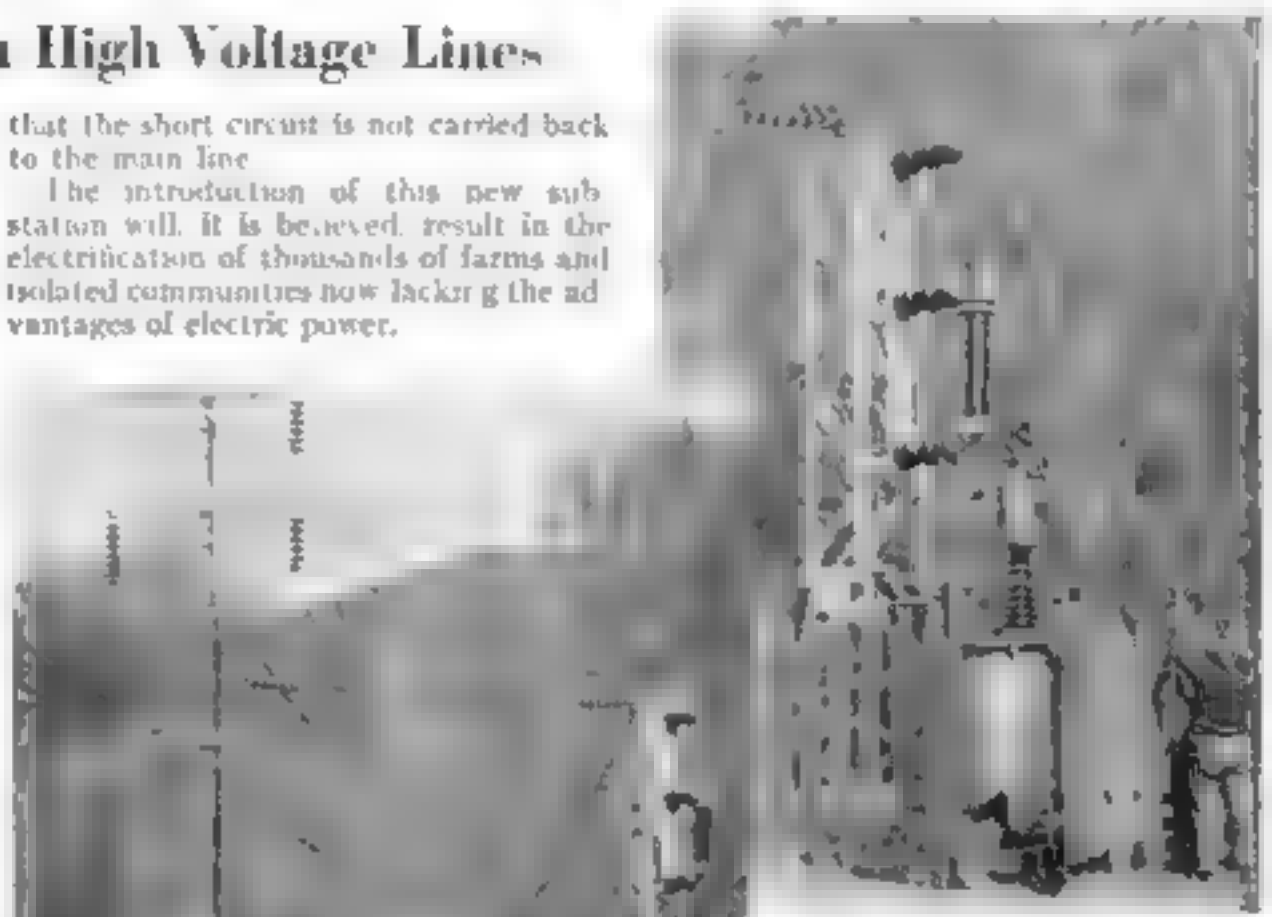
Farm Electricity from High Voltage Lines

HIGH tension lines, carrying thousands of kilowatts of electrical energy at high voltage, now can be economically tapped to supply current for farms and scattered villages along the line. The expense of installing elaborate substations has been eliminated by a miniature substation recently developed in the laboratories of the General Electric Company.

This miniature substation is fitted with a single-phase, oil-insulated, self-cooled, step-down transformer which takes the high voltage current from the line and transforms it to a lower voltage suitable for local distribution.

There is, of course, nothing new about the construction of such a transformer. Many thousands of step-down transformers are in use. The unique features of the new miniature substation are in the methods used to protect the main line against electrical troubles originating in the substation. As the illustration shows, extraordinary precautions are taken with the insulation so that if lightning strikes the substation the operation of the overland high tension line will not be affected. In addition, a short circuit on the local lines immediately operates to disconnect the entire substation so that the short circuit is not carried back to the main line.

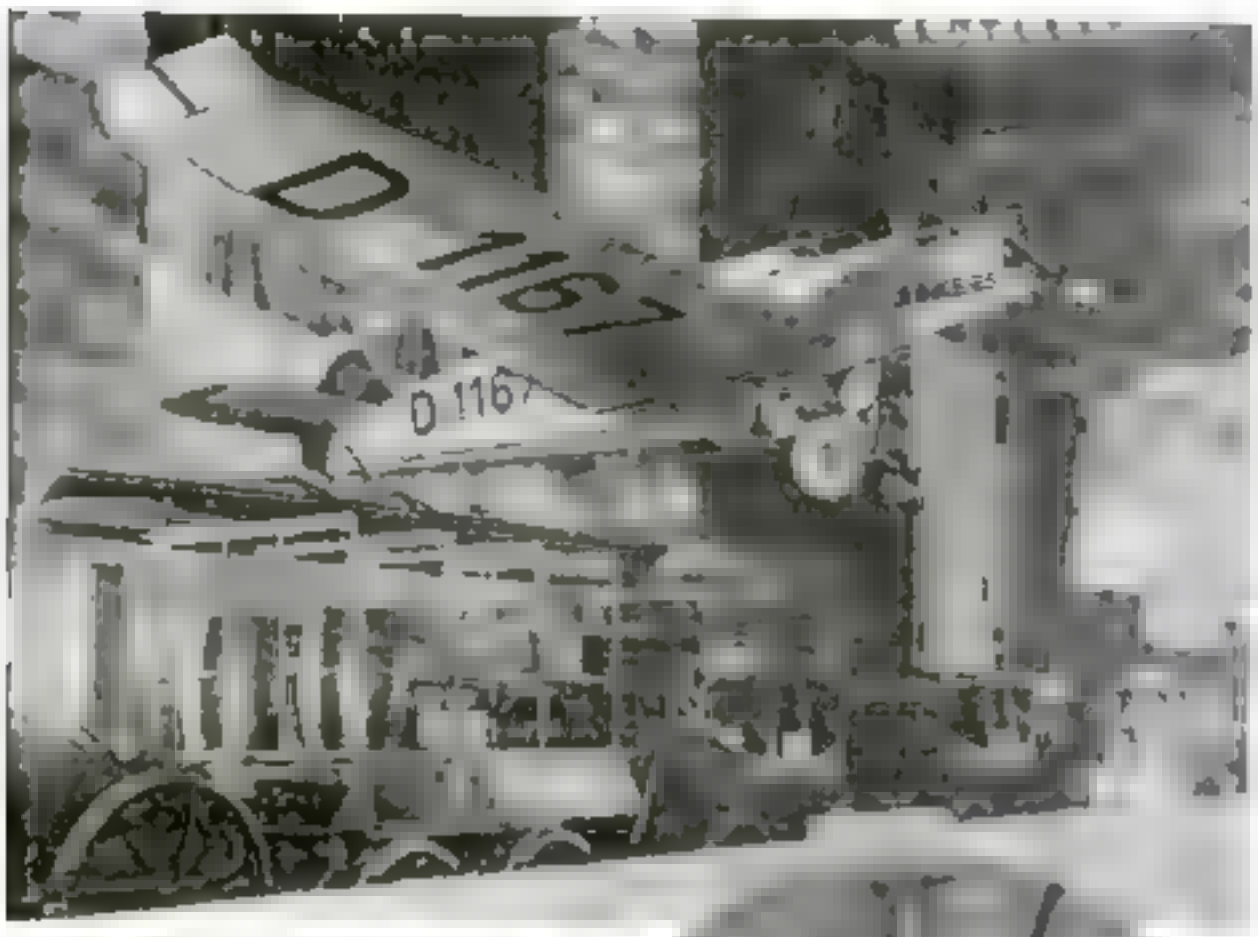
The introduction of this new substation will, it is believed, result in the electrification of thousands of farms and isolated communities now lacking the advantages of electric power.



One of the miniature substations. Elaborate insulating equipment protects high voltage line from lightning burn-outs.

Left: Another view, showing substation completely installed and connected with main line to supply farms.

Monoplane Bremen Goes to New York Museum



The *Bremen* hanging in Grand Central Station, New York [illegible]

THE *Bremen*, famous Junkers monoplane, which made the first westward crossing of the North Atlantic last year, recently arrived in New York City, where it will be kept on permanent exhibition in the Museum of Peaceful Arts. The machine was presented to the [illegible] by the late Baron von Huenefeld who with Hermann Koehl [illegible] pilot, and James C. Fitzmaurice Irish airman, made the historic crossing. It was first placed on [illegible] public exhibition in the Grand Central Terminal, and there was seen for the first time by the American public.

In landing at Greenly Island, off the coast of Labrador, at the end of the flight, the plane crashed and could not be flown on to New York. The "Three Musketeers of the Air" continued their journey in a relief plane, leaving the *Bremen* on the island to be shipped from there later.

Find Open Windows Are the Best Ventilators

OPENING the windows and letting Nature take its course is still the most effective way of airing a room, and no mechanical ventilating system thus far devised improves on this old fashioned method. Such is the conclusion just reached by the U. S. Public Health Service after a survey of schools to determine the frequency of colds, bronchial trouble, and other respiratory diseases among the pupils in relation to the means of ventilation used in the buildings.

The investigators found that in mechanically ventilated schools the number of pupils suffering from respiratory ailments was a little less than twice that in "open-window" schools, the percentages being three as against one and eight-tenths.

Auto Cigar Lighter Held by Suction Grip

A CIGAR lighter that can be installed on an automobile dashboard in a moment and requires no wires or batteries has appeared on the market. A rubber suction grip holds it to the dashboard. When its cap is pulled off, as pictured above, a file rasps upon flint, igniting the lighter, which is designed to burn any fluid used in the ordinary pocket device.

When not in use as an accessory in the motor car, it can be detached and carried in the pocket or stuck to a desk to provide a quick and handy light.

Alaska Hunts Destructive Wolves and Coyotes

WOLVES roaming the tundra of Alaska are killing off reindeer at the rate of about 100 for each wolf during a winter. More than 500 reindeer were killed by only five wolves last winter near Unalakleet, and the previous season 200 were slain by two wolves near St. Michael.

Coyotes also are taking a heavy toll of fur-bearing animals and migratory birds, as well as of sheep and caribou. They have destroyed entire colonies of foxes, and Alaska trappers are alarmed by the situation.

To end these depredations, the legislature of Alaska recently appropriated $30,000 for a hunting campaign against the predatory animals.

Soviet Machine Gun Fires Ten Shots a Second

TEN shots a second is the reported maximum speed of a new machine gun invented by a Russian and recently introduced in the Soviet army and air forces. Allowing for the time it takes to change the drums, the gun discharges 150 bullets a minute. The Lewis machine gun, used previously by the Russians, fires 125 shots a minute. The new weapon is said to be effective at a distance of about 2,400 feet.

Traffic Light Warning to Safeguard Pedestrians

A FEW years ago, a pedestrian was crossing a street at a busy corner in Cleveland, O. Just as he was halfway across, traffic lights changed and he escaped the unleashed automobiles only by a mad dash for the curb. As he walked on, an idea popped into his head.

That idea recently took completed form in an invention which the pedestrian, Herman Gechter, assisted by Dr. Ernst Watal, a Cleveland engineer, has perfected. It tells both pedestrians and motorists exactly how much time will elapse before traffic lights change. The device is a "clock," with a hand and a circular dial numbered from one to twelve, as in the usual timepiece, hand and dial are illuminated by neon light, as this is most easily seen at a distance. By glancing at the position of this pointer, an observer can determine whether the light on the traffic signal has just been turned on or is about to change. As the pointer touches twelve, the lights change.

Traffic signals equipped with new "clocks" will aid pedestrians crossing streets and motorists in gaging their speed.

The position of the pointer indicates the time before traffic lights are scheduled to change.

Erased Writing Revealed by Ultra-Violet Rays

ULTRA-VIOLET rays, used in the treatment of rickets and other ailments, now are being called to the aid of the historian and antiquarian. Recently Professor G. R. Köbel, of the University of Vienna, Austria, discovered that, by means of ultra-violet rays, the now invisible writings on palimpsests, the doubly-written parchments of Medieval times, may be photographed and deciphered.

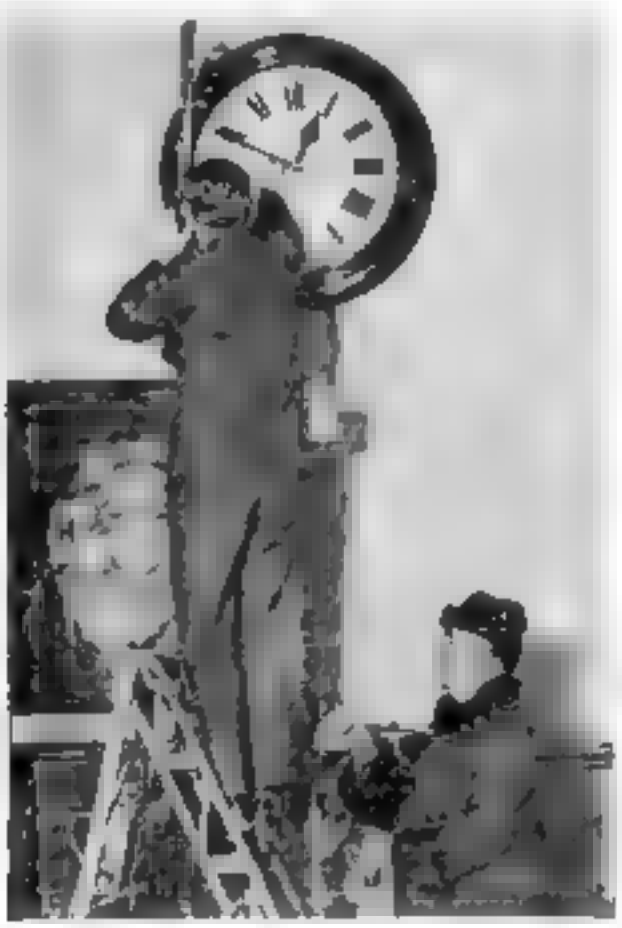
Parchment often was used twice and sometimes three times by the scribes of the Middle Ages, because of its cost and scarcity. The chronicler would erase, and frequently not very carefully, the writing from a document and use the same parchment again. By the new use of ultra-violet light, important historical, literary, and scientific data may be revealed.

American scientists have further discovered that various kinds of ancient inks may be brought to light by ultra-violet rays of different wave lengths.

Woman Sets Office Clocks by 100-Year-Old Watch

A WATCH that is said to have kept perfect time for a hundred years has provided its owner, Miss R. Belville, of London, England, with a steady income for forty years. Known as "The Clockwoman of London," she makes daily trips to a number of business houses, setting their clocks to the correct Greenwich time as told by the old timepiece, known as "Arnold 345."

The watch was made for the Duke of Sussex, son of King George III of England. Later it came into the possession of Miss Belville's father, an attendant at the Greenwich Observatory. He discovered its remarkable ability and started the unique occupation of supplying the correct time to offices, which his daughter, now seventy-five years old, still pursues.



London's "Clockwoman" supervising setting of office clock by her hundred-year-old watch.

Automobile "Tight-Ropes" on Power Line

H. Kambrinow, German dare-devil, driving his automobile on hundred-foot-high power lines.

A TIGHT ROPE-RIDING automobile recently thrilled watchers in the vicinity of Berlin, Germany, when H. Kambrinow, a dare-devil rider, drove the machine along parallel high tension wires for almost a fifth of a mile. At some places the swaying wires were a hundred feet from the ground, with yawning limestone quarries below, yet the heavy machine completed the trip safely at fifteen miles an hour.

The pneumatic tires had been removed, and the car ran on clincher rims, which held it to the wire. Before the perilous ride, the electric current in the wires was turned off at the power house to make the feat possible. Near the end of the performance, Kambrinow stopped the machine for a moment and, standing up in the seat, waved reassuringly to watchers in a gully below.

Three-Color Flashlamp Serves as Signal

A RED, green, or white light is possible with a new electric flashlamp pictured above. It is designed especially for policemen, motorists, and campers, for whom it serves as a handy method of night signaling. When both buttons on the front of the device are at the bottom, the light is white. Sliding one of the buttons up pushes a red shield between the lens and bulb and the light changes to red. If instead, the other button is moved up, the light becomes green. The first button to be manipulated must be returned to the lower position before the other one can be pushed up.

Another feature of the lamp is the arrangement of the three buttons at the top. One turns on the light, when pressed down completely. Given a slight pressure it can be used for flashing the light on and off in any of the three colors for "dot and dash" signaling. The center button locks the mechanism so that the lamp cannot become accidentally lighted while being carried in the pocket. The other button switches off the light. An adjustable leather strap permits the lamp to be carried in the hand, hung on the wall, or, whenever it is necessary, attached to a belt or button of a garment, leaving both hands free.

Plant and Bird Species Outlived Monsters

PLANTS and birds descended from species that lived millions of years ago still exist, while the large mammals and reptiles of prehistoric times, such as mastodons, dinosaurs, and giant armadillos, have been extinct for centuries.

This fact was revealed by recent excavations in two widely separated parts of the world. In the Sutschansk mines near Vladivostok, Siberia, a Russian paleontologist, found fossil plants 155,000,000 years old. What he discovered were really leaf prints in the rock, but these could clearly be distinguished as belonging to a genus of which the American wild sarsaparilla and the Hercules shrub are descendants.

In Florida, representatives of the Smithsonian Institution unearthed a fossil bed in which bones of ducks, geese, storks, and other present-day birds lay side by side with the remains of mammoths, ancient horses, and other creatures of at least a million years ago.

Claims Rubber Studs Make Tires Puncture-Proof

INVENTION of a rubber tire that cannot be punctured, though it contains no metal armor, is claimed by E. C. Walton, LaPorte, Ind., engineer. His tire is protected by studding the tread of ordinary rubber with hard rubber disks, arranged in several layers beneath the surface so that they cannot work loose. These disks are sufficiently strong, he says, to stop a nail or piece of glass from piercing the casing; yet they do not interfere with the normal flexing of the tire. Since no metal is used there is said to be no heating of the rubber, nor any possibility of cutting the fabric. The invention should add greatly to the life of tires.

American Hens Go In for Quantity Production

EFFICIENCY and mass production, watchwords of modern industry, have invaded the henhouse. Department of Agriculture statistics show that the United States had fewer hens last year than in 1927 but that the birds more than made up for the thinning of their ranks by laying a greater total of eggs.

At the close of the first half of this year, the number of hens was four percent less than last year, but again the "output" per hen was greater. In the same period, the hatch had increased six percent over the corresponding months of 1928.

Paper Made Fireproof by New Secret Chemical

IMAGINE a blow torch, used to cut through steel girders, playing for an instant on a piece of paper without singeing it, or a piece of wood resting momentarily unharmed in a white-hot blast furnace.

Those apparent reversals of nature's laws are said to have been accomplished by two experimenters in Los Angeles, Calif. By soaking paper and wood in a secret chemical preparation, Dr. O. T Hodnefield and Dr. W. W. Shartel report they have succeeded in making these inflammable materials virtually fireproof

The inventors, it is said, are prepared to manufacture their fireproofing chemical soon on a commercial scale. They predict it will make wooden structures as resistant to fires as stone buildings are

Dr O T Hodnefield, co-discoverer of new fireproofing chemical, shows how it protects wood from a blowtorch flame.

Blocks Simplify Nailing in Fireproof Walls

Left: Inserting corrugated nailing blocks in mortar joints of a tile wall before cement is poured for nailing base behind the wall.

Below: Attaching nailing block to metal lath by means of a specially shaped wedge.

TWO recent inventions in building provide convenient nailing blocks for attaching baseboards, picture molds, or wall panels to walls made of hollow tile or terra cotta, or containing metal lath. For the metal lath, square steel clips, each with an opening on one side that allows it to be slipped on one of the narrow metal uprights, provide anchors for wooden wedges driven into the clips to form nailing blocks. For tile walls, blocks of wood, faced with upright grooves to give the mortar a firmer hold, are cemented between the tile ends.

According to the manufacturer, these devices make possible a fifty percent saving in labor and a reduction of more than half the costs in providing nailing bases in fireproof buildings. More than twenty-five thousand of the new clips and mortar joint blocks are said to have been used in one office building in Los Angeles, Calif., recently.

Eggs, Beans, and Milk Cause Strange Ailment

IN A recent report to the American Medical Association, two physicians of St. Louis, Mo., described a disease which resembles hay fever in its causes. They told of persons suffering from [illegible] on the face or body after eating small quantities of eggs or beans, or drinking as little as one spoonful of milk. This disorder, the doctors explained, is caused by oversensitiveness to the proteins in these foods, just as hay fever is due to sensitiveness to the proteins in the pollen of certain plants, resulting in inflammation of eyes and nose. The purple spots are the result of blood escaping from small veins and arteries just underneath the skin, producing 'chemical bruises.'

Habitual sufferers from hay fever in the United States may escape its discomforts by going to Europe, where, according to medical experts, the disease is much less prevalent than in this country. There are also, however, some "hay-fever proof" localities in the United States. Of these the White Mountain region in New Hampshire is best known.

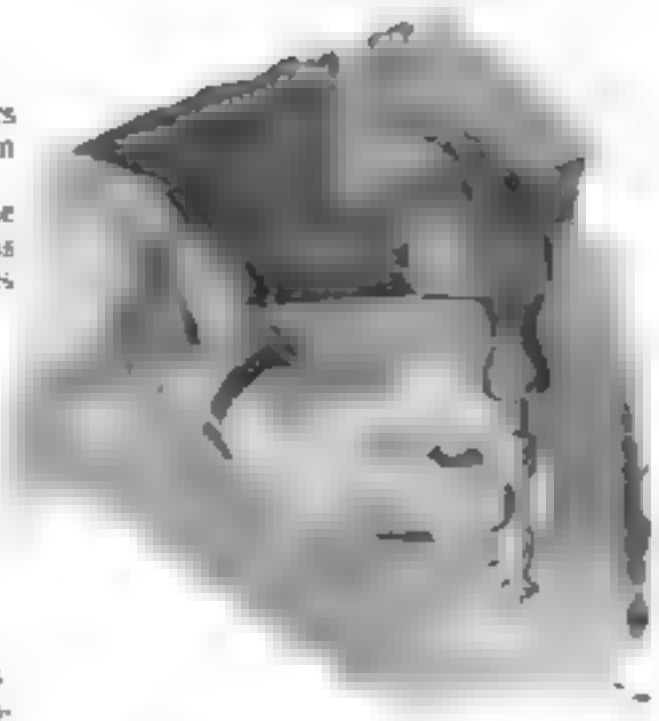
Radio May Set Watches

WATCHES soon may be set automatically by radio if plans of an American timepiece manufacturer are successful. There is a race between this firm and a German concern, to produce the first radio-regulated timepiece that is practicable, according to Louis G. Caldwell, former general counsel of the U. S. Radio Commission. If it can be done, the watch of the future will keep observatory time so long as it is running.

Air's Ozone May Be Caused by Sunspots

PART of the ozone, that mysterious and healthful form of oxygen in the earth's atmosphere, may be produced by sunspots. Dr. F E. Fowle, of the Smithsonian Institution, Washington, D. C., recently advanced the theory that, while one layer of ozone in the atmosphere is created by the ultraviolet light of the sun, another owes its origin to minute particles emanating from sunspots and shot at the earth by billions. This theory the physicist bases on his observation that ozone is absent from the upper layers of the atmosphere during a minimum sunspot period

Ozone, which was first observed by the Dutch scientist van Marum in 1785, has a faint blue hue and its odor resembles that of chlorine. The smell usually attributed to phosphorous is really that of ozone. It is strongly noticeable in the vicinity of an object which has been struck by lightning and near electrical machinery



Sculptured Panels Beautify Fire Escapes

COMBINING beauty with utility, a California architect recently designed a new type of fire escape which constitutes not only an effective means of rescue but also an escape from the ugliness of the conventional gratings and ladders.

In his plans for the headquarters of a Hollywood motion picture concern, he substituted for the usual iron framework a series of decorative concrete balconies, connected between floor levels by a system of steel stairways. As a rule fire-escapes, because of ugliness, are placed at the sides or the back of buildings. But the Californian found that they could be made to strike a decorative note in his design, and so he included the balconies in his scheme for the front of the structure, overlooking one of the main streets

The new fire escapes produce a pleasing architectural effect and, besides, are attractive in themselves. Each balcony, on its face and sides, is embellished with sculptured figures cast in concrete panels. In keeping with the purpose of the building, the relief design represents a scene in a motion picture studio, curiously executed in classical style. It shows a group of actors playing before a camera, together with their director and other studio attaches, all of them portrayed as they might have appeared in ancient Greece if the Greeks had had movies and movie studios. Smaller designs for the sides of the balconies are carried out in similar fashion

Figures in relief also adorn the cantilever beams supporting the balconies. To carry through the scheme, concrete plaques featuring classical dancers are set into the facade of the building

The plan may be followed in designing other buildings, by changing the decorative theme to suit Plaster molds can be made from a sculptor's full size model, and with these molds as many panels as are needed can be cast. In case a vivid effect is desired colored concrete may be used

A close-up view of one of the sculptured panels, cast in concrete, that adorn the fire escape balconies. Top: Decorative fire escapes on the front of the Hollywood building.

Self-Centering Nail Set New Aid to Carpenters

TIME is saved in setting nails, or driving their heads below the surface of wood in finishing work, by a new tool designed to eliminate the usual hand held punch. A conical opening at the bottom of the tool pictured above, automatically centers the nail head below a plunger which is struck with a hammer to set the nail. A spring forces up the plunger after each nail is set. The self-centering feature is said to prevent marring the wood, as often happens when an ordinary punch slips off the nail as it is being struck

Radium Experts to Fight Cancer in Cities

WITHIN a few years every large city in the United States will have a "cancer institution," equipped with from $500,000 to $1,000,000 worth of radium treatment apparatus and manned by a staff of experts and surgeons. Such was the recent prediction of Dr. James Ewing, head of the Department of Pathology in Cornell University, Ithaca, N. Y., and a noted cancer specialist.

These institutions, Dr Ewing said, will be established by the various state health departments, with the aid of private philanthropists, as an integral part of a nation-wide cancer-control program that is sure to be executed in the near future.

Hands and Feet Missing in Brazilian Family

IN TWO generations of a Brazilian family reported to the Eugenics Research Association, five of the members have been born without hands or feet. Three are children. Their father, similarly crippled, died recently. One uncle, also deformed, still lives. In explaining the strange case of hereditary deformity, biologists say the tiny living granules, called chromosomes, contained in every living cell, transmit characteristics from one generation to another. It is evident, they say, that the chromosomes of the Brazilian family lack some essential unit in their structure. This missing unit is the one responsible for the formation of feet and hands.

All Skins Contain Similar Colors, Tests Reveal

THAT the skin pigment of the so-called black, yellow, and red races does not differ from that of the white race except in quantity is the conclusion of two scientists at the Mayo Clinic and Foundation, Rochester, Minn.

Using a spectrophotometer, or color analyzer, they have made a study of skin coloring in regard to vividness, hue, and amount of light reflected. They found that some men are black and others white not because of different-colored pigment, but because varying amounts of the same pigments reflect light in different degrees. Large quantities of pigment hide the blood in the superficial layers of the skin, and the investigators discovered that this blood affected the color of the skin even more than the pigment itself. The quantity of pigment present, they say, probably is due to the amount of exposure to sunlight through countless generations.

Engineers Like Blondes; Farmers Like Chickens

THE fact that a man prefers blondes to brunettes may indicate that he should be an engineer instead of a lawyer farmer, clerk, or mechanic, according to Prof H H Remmers, of Purdue Univer sity. In a recent questionnaire submitted to agriculture and engineering students, he discovered that the engineers like short women, blondes, shopwork, city life, and methodical people. The prospective farmers like Jersey cattle, caring for chickens, digging in the garden, excursions, polite people, and work with children

Diving Reporter Phones from River Bottom

Above Lindesay Parrott, New York news [illegible] of the East River [illegible] the diver and the [illegible]

LINDESAY PARROTT, a New York newspaperman, claims to be the first reporter to phone a story to his editor from under water. Recently he sent in a feature story while standing on the bottom of the East River, between Manhattan and Brooklyn. Attired in a diving suit and helmet, he was lowered over the side of a tugboat and began his descent

As he slowly sank into the darkness below the surface, he began a running story of his sensations and experiences, speaking into a telephone instrument installed within the diving outfit. The story was transcribed by a man at the other end of the phone connection in the news room of the paper and was on its way to the presses before the bulletlike helmet of Parrott s diving suit appeared above the waves after he had been hauled to the top without mishap.

Camera Records Unusual Lightning Display

AS A jagged streak of lightning twisted across the sky over the office buildings of downtown Chicago during a recent thunderstorm, a photographer on Michigan Avenue obtained the remarkable photograph at the right, catching the brilliant streak of millions of horsepower of electrical energy as it appeared framed by skyscrapers.

A flash of lightning, defined in its simplest terms, is merely a powerful electric spark. Billions of electrons accumulate on the clouds, and, when the crowding becomes too great, the electrons jump to the earth or to another cloud. That jump forms the lightning flash.

There are approximately 1,800 thunderstorms continually raging on the earth, it is estimated by meteorologists, and every second, somewhere in the world, a bolt of lightning is discharged from the sky. The electricity wasted in these destructive flashes surpasses many times the combined output of all the world's power houses. The latest steps of science to capture some of this waste energy were described recently in POPULAR SCIENCE MONTHLY.

A brilliant streak of lightning, framed by Chicago skyscrapers, as caught by a lucky photographer during a recent storm.

The Stone Age Girls Used Lipsticks and Mirrors

ALTHOUGH $100,000,000 is spent in the United States each year for cosmetics—more than ten times the sum this country sets aside annually for scientific research—American women are by no means the inventors of this form of facial adornment, nor are their present-day European sisters. The art of make-up, almost as old as the human race, had reached a high point of development among the ancient Egyptians, Greeks, Romans, and other peoples.

Recently it was discovered that the Irish colleen of the Stone Age, more than 2,500 years ago, used a lipstick. In graves of the period unearthed accidentally in the course of harbor improvement work on Lambay Island, off the Irish coast near Dublin, representatives of the Dublin Museum found sticks of waxlike pink paint which they declared the belles of long ago employed to heighten the color of their lips. Other interesting articles found in the graves included metal brooches, stone finger rings, and bronze bracelets. There also was an iron hand mirror which, according to experts, never possessed a high polish, but which was turned into an implement of reflection by dipping it first in water

Two Cross the Channel on Water Bicycles

Two "Channel-cyclists"—Roger Vincent above pedaled across in only five hours Miss Aimee Pfanner right in mist.

A PEACEFUL invasion of England on water bicycles took place recently when a French sportsman and a twenty two-year-old girl pedaled their way safely across the twenty-odd miles of rough sea water separating Calais, France, from Dover.

The first trip was made by Roger Vincent, who "bicycled" his way across the English Channel in slightly more than five hours, in spite of high seas and strong contrary winds. When nearing the white chalk cliffs of Dover, the sprocket chain of his machine broke and he had to climb down on the floats to repair it. Later the hydrocycle was caught in a strong offshore current, giving the plucky rider a hard battle for more than an hour before he touched land. A fishing tug, carrying official timers, accompanied him.

Using a similar machine a few weeks later, Aimee Pfanner, a mannequin of Paris, made the trip in nine hours and nineteen minutes.

She was trained for the trip by Rene Savard, who made what is believed to have been the first hydrocycle crossing, in 1927. His time for the journey was six hours and six minutes—only an hour more than the record made by Vincent.

Crack Train Cuts Time Across the Cascades

RACING over winding rails in the shadow of snow-covered peaks, the *Empire Builder*, the Great Northern Railway's latest crack train on the Chicago-Seattle run, recently inaugurated a new sixty-one-hour schedule between the two cities. The striking action photograph at the right was snapped as the train's giant locomotive rounded a curve after battling deep snow in a pass of the Cascade Mountains.

Such service requires a specially articulated engine, built with the driving wheels in hinged units to permit it to traverse the sharp mountain curves.

With increasing competition from time-cutting aerial transportation, railways the world over are speeding up their trains. A new Italian locomotive is reported to have shown unusual power and speed in recent tests. It will operate between Milan and Venice.

The *Empire Builder*, the Great Northern's new Chicago-Seattle express, thundering through the Cascade Mountains

"Dry Ice" Offers a New Remedy for Leprosy

LEPROSY, regarded for centuries as an incurable disease, has in the past few years been treated successfully with chaulmoogra oil, obtained from an East Indian tree. This method, however, has two disadvantages—the treatment takes several months and the oil is so nauseating that it cannot be administered in very large doses.

Dr A Paldrok, a skin specialist at the University of Dorpat, in Esthonia, recently announced that he had developed a new leprosy cure which will do away with the shortcomings of the chaulmoogra oil treatment. By his method, areas of the infected skin are frozen with solid carbon dioxide, or "dry ice." Compounds of gold also are used in the treatment.

The intensely cold material is said to kill the tissues for some distance below the diseased surface. The dead tissue cells discharge chemical substances into the blood which stimulate the body to repel scattered leprosy germs.

Anger and Fear Born of Childhood Diseases?

IF A person is quick-tempered or timid, or both, he is more to be pitied than scorned, for he probably is still a victim of diseases suffered when a child, according to Dr George M Stratton, of the University of California

Experiments with students conducted by Dr Stratton indicated that those who had suffered the most diseases in childhood were most susceptible to anger and fear. A record of the frequency of their emotion was compared with the students' medical histories. It is Dr. Stratton's theory that early diseases undermine the nervous system and glandular constitution, weakening their resistance to later emotional shocks.

...e Window Sash Cord

Broken-away view of window showing spring and roller device which replaces the sash cord.

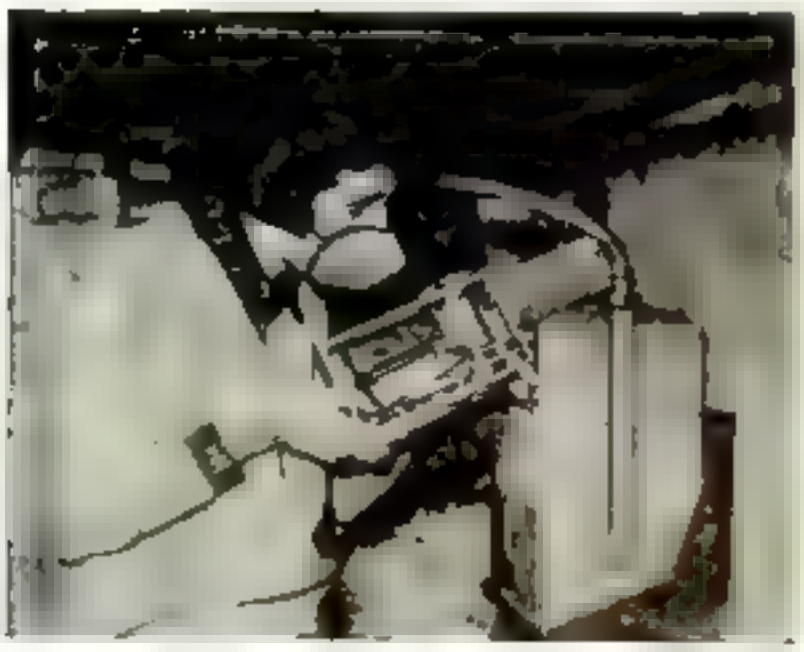
windows like those in private motors, which afford an unobstructed view and can be lowered and raised like automobile windows. In addition, the car has form-fitting seats, a floor of non-skid composition, and soft, subdued lights.

Automatic Detector Gives Warning of Gas Leaks

AN AUTOMATIC detector to locate gas leaks or warn of the presence of fire-damp in mines has been invented by a woman in Paris, France. Whenever the quantity of gas in the atmosphere is greater than 1.3 percent the instrument sounds a warning by ringing a bell and flashing a tiny electric lamp.

Tests made in England as well as France are said to have indicated that the invention infallibly detects the presence of gas in the air. In France, it is being used to trace leaks in household gas lines and fixtures, and to insure that no gas escapes from loose plumbing joints when new meters are installed.

The London street gas explosions of some months ago inspired the inventor



Locating a gas leak with the automatic detector. Excessive gas rings a warning bell and flashes a light in the instrument.

Dry Air in Homes Causes Rugs to Wear Out

IN WINTER, the air in the average American home has less humidity than that over the Sahara desert. A kiln for drying lumber contains more moisture than a typical American room. These surprising facts were discovered during a recent study, in New York state, of the effect of dryness upon valuable rugs.

Health authorities say that from thirty to forty-five percent humidity should be maintained for the most healthful living conditions. Yet most homes in cold weather have less than twenty percent, the report shows.

As much as a bathtub full of water, from twelve to twenty gallons, should be evaporated every day in a good-sized house, to keep the humidity at the comfort point during zero weather. One of the contributory causes of wear in valuable rugs, the report points out, is insufficient humidity. In its natural state, wool holds thirty-five percent water. A reduction in moisture causes the rugs to "fuzz-out," thus losing part of the fine wool woven into them

Talkie Actors Rehearse on Skeleton Stage

A BROADWAY actor who had entered the "talkies" told in POPULAR SCIENCE MONTHLY, a few months ago, how the tearing of a piece of paper during the filming of one talking picture had spoiled a sound sequence that cost approximately five hundred dollars. Slight mistakes on the stages where talking movies are produced may mean losses of thousands of dollars when elaborate equipment is used to record actions and spoken words at the same time.

As a result, skeleton sets for rehearsals only are now part of the equipment of the Hollywood "talkie" studios. These rehearsal stages are laid out with the same measurements as the actual sets and include lettered signs to indicate doors, "windows," and other features involved in the scene. Here the players go over their lines and stage business in consultation with directors and authors. The scenes are letter-perfect before they are transferred to the "shooting" set.

The photograph above shows Herbert Brenon, film director, going over a scene with Fannie Hurst, author (at his right), Winifred Westover, actress, and Karl Struss, photographer

Relief, Not Sorrow, Real Cause of Weeping

IN MOST cases, neither sorrow nor joy but rather relief from the tension induced by either one of these emotions is the real cause of tears. Dr Frederick H. Lund, of Bucknell University, and Dr. H. V. Pike, of Danville State Hospital of Pennsylvania, after an investigation of the causes of weeping, recently reported this conclusion to the American Psychological Association.

Working on subjects with pronounced emotional reactions, the investigators found that weeping rarely occurred in a state of dejection or elation, but mostly when the depressing mood was alleviated by brighter circumstances or when calm set in following too great a joy.

Boys Need More Sunshine than Girls for Health

THAT "boys are harder to rear than girls" was recently given support by statistics issued from the Children's Bureau of the U. S. Department of Labor, in Washington, D. C. These reveal that, although more boys are born in the United States than girls, the latter have thirty percent more chance of living. During the first year, 130 boy babies die for every 100 girls who fail to survive.

One reason for the higher mortality among male infants is indicated by Dr Henry Baldwin, of Columbia University, who recently reported he had found that boys need more sunlight than girls, developing rickets and other diseases more readily when deprived of the beneficial rays of the sun. During months of plentiful sunshine, the death rate of boy and girl babies becomes practically equal.

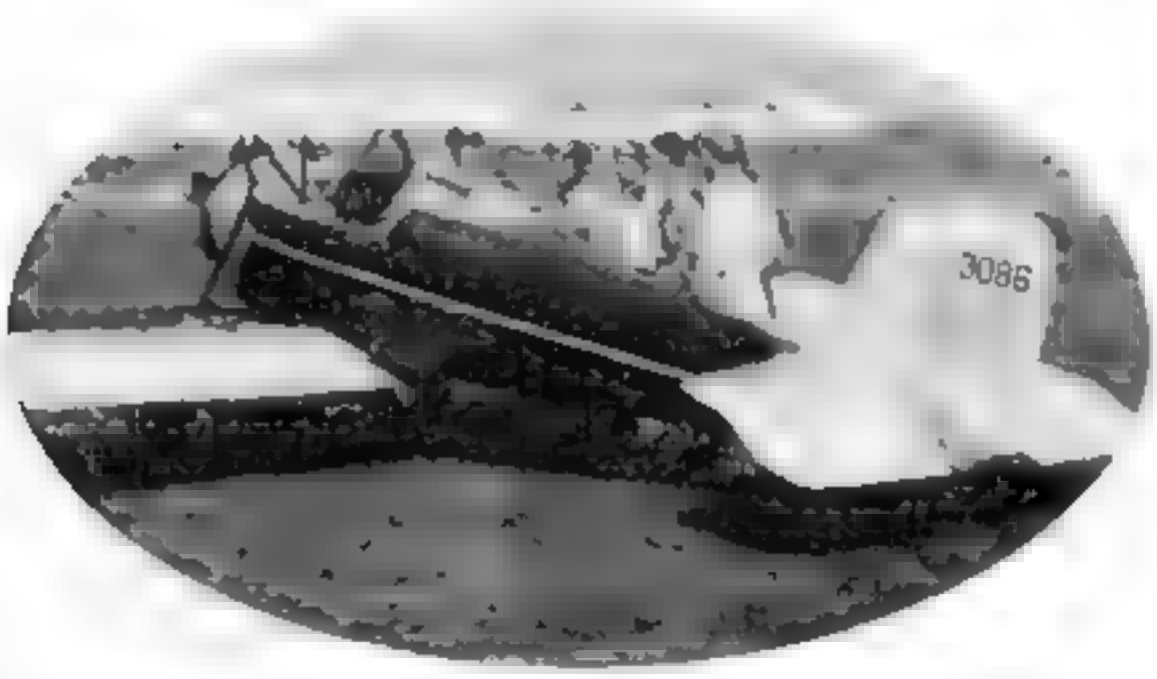
Mechanical Nurse Holds the Baby's Bottle

A MECHANICAL baby-bottle holder, designed to relieve mothers of the strain of holding the bottle while infants finish their meals, was recently exhibited in Chicago. Attached to a weighted base is a flexible arm similar to those used on desk lamps. Clamps at the end of this arm hold the bottle, which can be adjusted to any position.

When the meal is over, the "baby diner" is taken away. Its flexible arm can be bent down, permitting it to be stored in a small space when not in use—a further advantage.

Just a minute, please. He'll be happy as soon as the flexible arm is bent to place the bottle in the right position for his meal

Five Brothers Build an Unusual Airplane

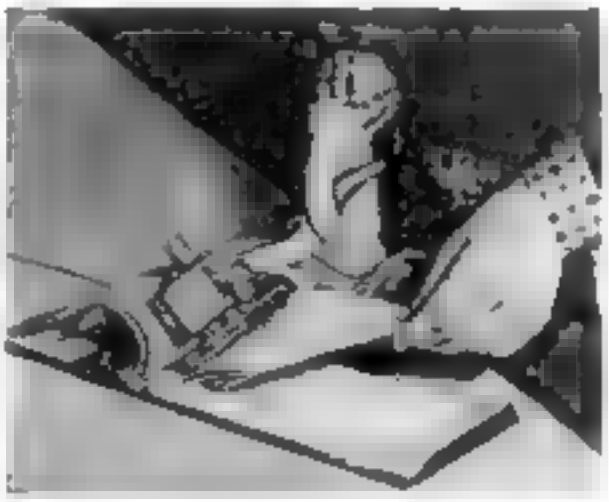


WHEN five brothers of Madison, N. H., constructed their own airplane, they included features not found in more conventional models. Following the design of Z. D. Granville, twenty-eight, oldest of the quintet, they put the joy-stick on the dashboard instead of in the floor, to give the pilot more room, and made the top wing adjustable for high or low speed flying. The photo shows the plane's designer in the cockpit, and the four other builders standing by

Substitutes for Store Clerk's Handwriting

A FEW months ago, P. A. Best, director of one of London's large stores, told in POPULAR SCIENCE MONTHLY of the need of a new style of handwriting that would enable clerks to write fast and foolproof records. Illegible sales slips, he estimated, cost department stores millions of dollars a year.

A recent American invention is said to help remedy this situation, preventing errors that result in misdirected parcels. Each customer is given a small metal plate, or address token, to carry in his pocketbook. Upon it is embossed the customer's name and address. In making a purchase, he hands the plate to the clerk who places it into a small hand-held imprinter. When the sales slip and duplicates are slipped between the jaws of the imprinter and the handles squeezed together, the name and address are



Stamping name and address of a customer on the sales check with the new hand imprinter

stamped correctly upon all of the slips.

According to the manufacturer of the device, this procedure eliminates error and saves time for clerks and customers.

Tiny One-Cell Creature Wears Life Preserver

THOUGH composed of only one cell and not much larger than a pin-point, the arcella, a tiny creature that inhabits the ponds and streams of Europe, carries its own life-saving equipment within its microscopic body. The late Dr. E. J. Bles of Cambridge University, England, discovered not long ago that the minute animal, which lives in a miniature shell, possesses a chemical mechanism by which it saves itself from drowning. When the arcella sinks into water containing insufficient oxygen for its needs, this mechanism automatically fills a hole in its little body with gas. Thus rendered lighter, the arcella shoots up to the surface.

Aluminum Coat Prolongs Life of Duralumin

A THIN coating of aluminum over duralumin, the light metal used extensively in dirigible and airplane construction, was shown in tests made by the U. S. Bureau of Standards to prevent corrosion which makes the high-strength alloy brittle and weak.

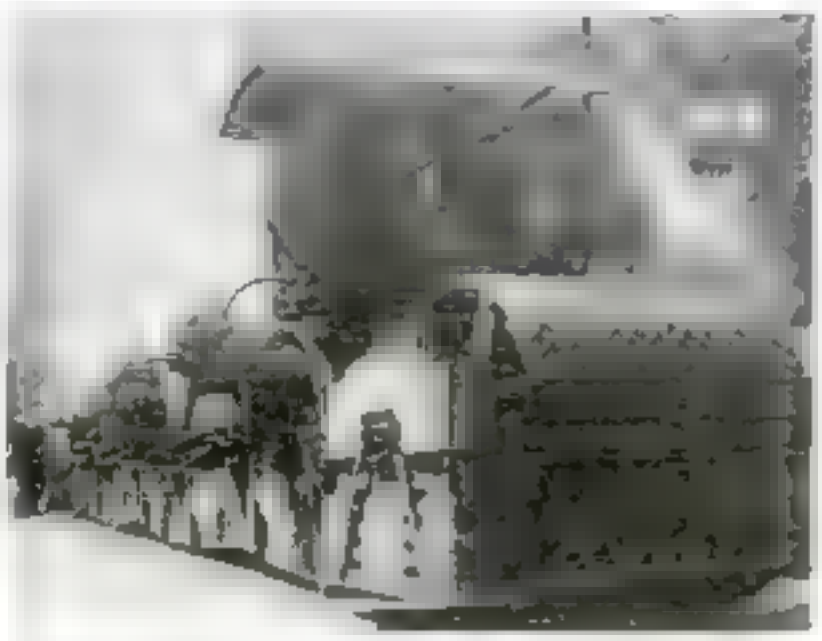
A "wiggle machine" played an important part in the tests that led to the discovery of the protective coating. Specimens of duralumin were corroded in salt water while being stressed by being bent back and forth by the "wiggle machine." The aluminum-coated duralumin proved superior to the uncoated metal.

Paraffin to Heal Lungs

BY INJECTING paraffin into the chest, Dr. Hugo Hauke, a surgeon of Breslau, Germany, has speeded the recovery of tuberculosis patients, he reported recently to a surgical congress in Berlin. During pulmonary tuberculosis, cavities form, particularly in the upper lobes of the lungs, and prevent the curative process, Dr. Hauke explains. If the diseased parts of the lobe are cut away from the chest, the cavities will collapse; paraffin injected into the resulting space will hold them flat

New Antiskid Pavement Made Like Waffles

"WAFFLE pavement" is the latest protection against skidding in Berlin. When an asphalt street was laid recently in the German capital, a huge "centipede" machine with several rollers, in a train ran over the hot surface to give the final leveling. The rear roller, with criss-cross ridges, marked the surface of the asphalt like a waffle to provide additional traction for automobile wheels. Tests are said to have shown the nonskid pavement to be effective in wet weather, reducing the number of accidents. It is expected that the new surfacing will be tried in other parts of Germany as well as in Berlin.



The last of this huge train of rollers impresses criss-cross lines in hot asphalt pavement as a safeguard against vehicles skidding.

Another unusual method of combating skidding on pavements has been reported from Paris, France. Layers of rubber were placed at street corners to help autoists to stop quickly and with less skidding.

Physical Comfort a Guide to Good Ventilation

PHYSICAL comfort should be the guide in the matter of house ventilation according to experts of the U. S. Public Health Service. The idea that all out-door air is "fresh" is a fallacy, they say, and so is the notion that sleeping with wide-open windows, regardless of temperature and weather, is necessarily healthful. The air from the outside, especially in cities where it is poisoned by smoke, dust, and various harmful gases, is often less desirable than that indoors.

As for bedroom windows, the experts have calculated that, on a cold winter night, enough air leaks between the sash and the casement and between the upper and lower halves of a closed window not provided with weather stripping to supply one adult with about 180 times the quantity of air he requires.

Still, the Health Service does not advocate sleeping with closed windows, any more than it advises going to bed with chattering teeth, a practice which is called far from healthful.

More Women Flat Footed; Jobs Are Blamed

A SUDDEN increase of flat feet among women has been noted by a German orthopedist, Dr. Gustav Muskat. In the past, he says, approximately twice as many men as women have had flat feet, but recently the ratio has changed, so that now it is three to five against the women. He attributes the change to the many women in "gainful occupations."

How Much Do You Know About Photography?

TEST your knowledge with these questions, chosen from hundreds asked by our readers. You will find the correct answers on page 156.

1. Why is the picture on a film reversed—black where white should be?
2. What is the difference between a fast lens and a slow one?
3. Who took the first photograph?
4. How do you determine the best focal length for a lens?
5. Why do pictures of racing automobiles always look distorted?
6. Why are special lenses needed to take colored movies?
7. How big can an enlargement be made without becoming fuzzy?
8. What is the difference between an anastigmat lens and the cheaper lens, except the price?
9. What makes stereoscopic pictures look so natural?
10. What is the difference between a lens marked f/8 and a lens marked f/6.3?

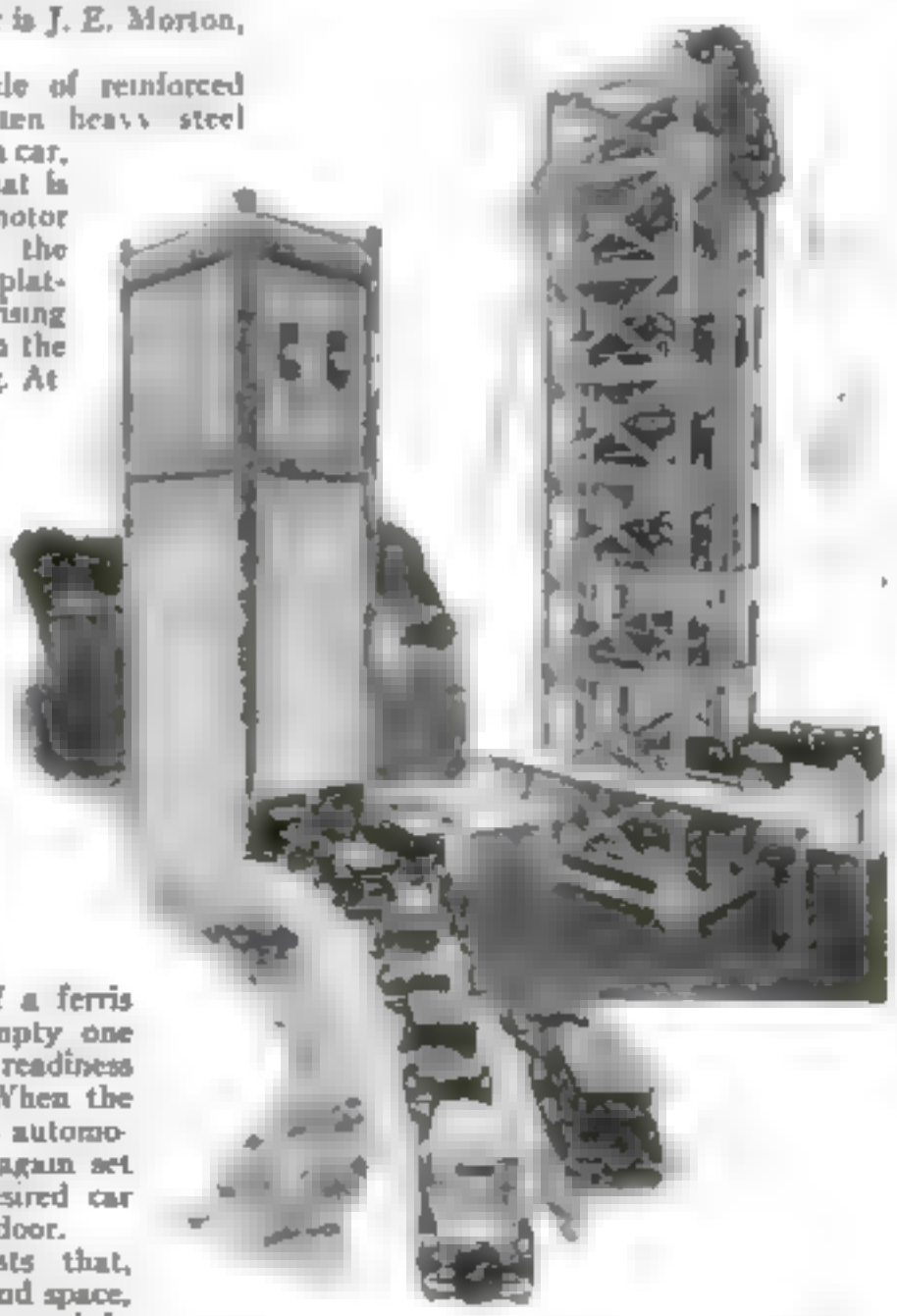
Novel Tower Garage Parks Autos Five Deep

AUTOMOBILES are "stacked" five deep in a novel experimental parking tower recently opened at Sandusky, O. Occupying ground space no greater than that required for an ordinary two-car garage the tower accommodates ten machines. The inventor is J. E. Morton, a Sandusky engineer.

The building is made of reinforced concrete. Within it, ten heavy steel platforms, each holding a car, form an endless belt that is moved by an electric motor located at the top of the tower. Thus while the platforms on one side are rising with their cars, those on the other side are descending. At top and bottom the platforms slide across from one "column" to the other.

Double doorways are provided at the ground level so that two machines can be driven into the unique "hanging garage" at the same time. The motorist who wishes to park his car in the tower, drives in through the doorway and leaves the machine. Then the platforms are moved like the cars of a ferris wheel until another empty one reaches ground level in readiness for the next patron. When the motorist returns for his automobile, the machinery is again set in motion until the desired car reaches the level of the door.

The inventor suggests that, without additional ground space, the towers can be increased in height to accommodate sixty automobiles and yet be perfectly safe. Having made and tested a working model of a sixteen-car tower, he proposes hundreds of similar parking towers, erected at various parts of a city, to solve the parking problem and speed up traffic.



Experimental ten-car parking tower at Sandusky, O. It requires no more ground space than the average two-car garage. Above: inventor's model of sixteen-car tower.

American Shad Shipped to Japan by Millions

ANOTHER "round-the-world" trip is being taken—this time by a species of herring, the American shad. From Oregon rivers young shad are being transplanted to Japan, with such success that the Japanese government plans to spend large sums to further the work. Last year 3,000,000 fry, shipped in Columbia River water in barrels, were transported across the Pacific. This was the second stage in a trip which began some years ago when the shad was moved from the North Atlantic coast to the Pacific.

Health Cards Proposed

THE municipal health department of Bordeaux, France, proposes to ask all citizens to carry cards which will contain a record of every disease the bearer has suffered, every operation he has undergone, and other notations concerning his health. The purpose is to aid hospital surgeons in compiling a "case history" in the event of an accident. Carrying of the records will be optional in Bordeaux, but some European health authorities wish to make it compulsory, to aid in detecting persons with contagious diseases.

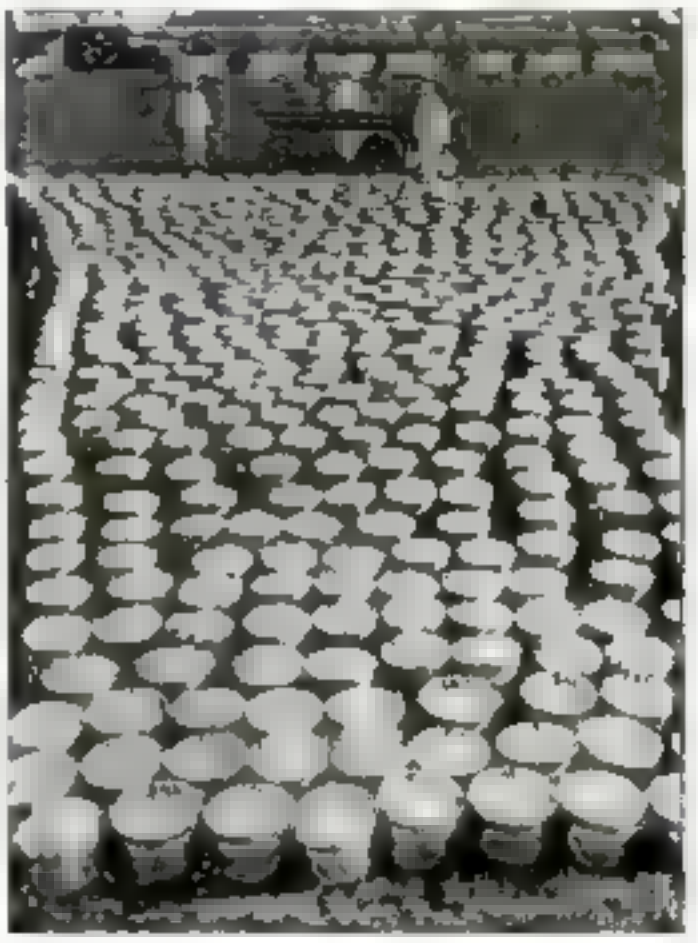
This Poultry Farm Has 300,000 Laying Hens

MORE than 100,000 eggs are collected every day at one of the world's largest poultry farms, near Los Angeles, Calif. On this hundred-acre ranch are housed 300,000 laying hens—equal to the total population of a city the size of Denver, Colo. Add to this number the 200,000 baby chicks which are being raised to become egg producers, and the total becomes half a million.

To feed this flock of cacklers, a million pounds of chicken feed is used annually.

Scientific methods of feeding and sanitation and the latest mechanical and electrical equipment are employed to increase production. A small army of workmen is required to care for the flock and look after their daily needs.

In the photograph are seen hundreds of pails filled with about three fourths of the daily yield, valued at more than $5,000. About a third of the entire population of the United States could be supplied with an egg from the annual production of this one farm.



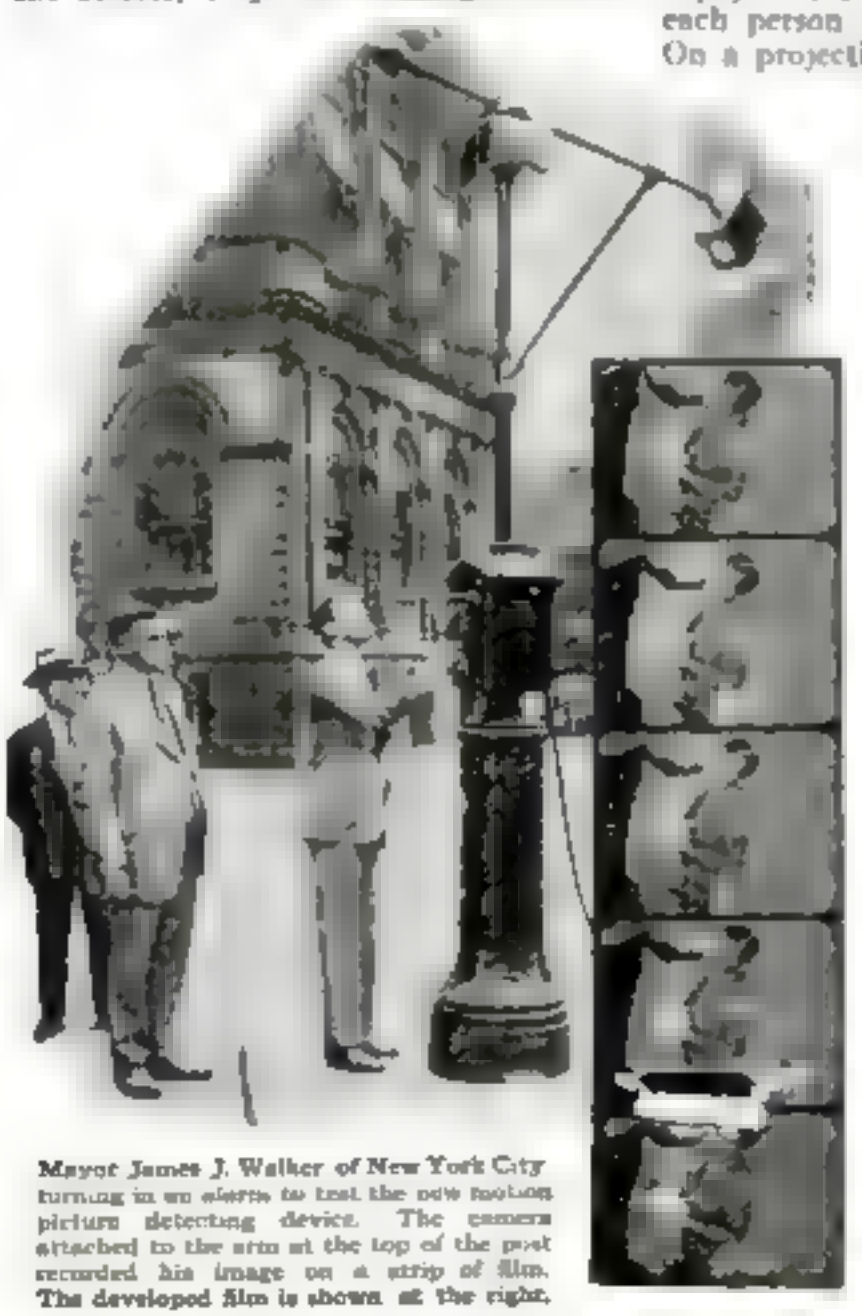
Eggs by the thousands. Here is part of one day's work of 300,000 hens on a farm near Los Angeles.

Movie Camera Detects False Alarm Jokers

MORE than 7,000 false fire alarms were turned in last year in New York City alone. Nearly one out of every four times that the fire engines dashed through the streets, they were wasting time and money responding to a false alarm.

To protect the city from the costly pranks of practical jokers, a new fire alarm box, equipped with a mechanical "eye," has been designed to photograph each person who turns the alarm key. On a projecting arm above the post to which the alarm box is attached a motion picture camera is focused upon the box. When an alarm is turned in, the camera automatically exposes a strip of film for a photographic record of the person below. If the alarm proves false, the film gives the police a means of identifying the culprit.

Mayor James Walker, of New York City, recently tested the invention. Fifteen minutes after he had turned the key, a film showing him performing the act had been developed. The camera is noiseless and the films can be preserved for future reference at police headquarters.



Mayor James J. Walker of New York City turning in an alarm to test the new motion picture detecting device. The camera attached to the arm at the top of the post recorded his image on a strip of film. The developed film is shown at the right.

THE NAMES and addresses of manufacturers of devices described on these pages will be supplied on request wherever possible. Write to the Information Department, Popular Science Monthly, 381 Fourth Avenue, New York City, inclosing a self-addressed stamped envelope for reply.

Grasshoppers Have Valves for Breathing

GRASSHOPPERS, which, like all other insects, have no lungs, breathe through an intricate system of air tubes ending in tiny valves in their sides. The insects are able to control the operations of these pipes and portholes at will.

These facts were revealed in experiments conducted the other day by James M. McArthur, a Louisiana entomologist. To study the grasshopper's breathing system, he placed some of the valves under water and sealed others with varnish. He found that the insects can control the working of the tubes, just as human beings can breathe through the mouth or the nose. He discovered, too, that when a grasshopper prepares for a jump, its muscular motions pump air in and out of the small breathing pipes, through which the air is carried directly to the various organs of the insect's body.

Finds X-Rays Futile for Speeding Up Evolution

THE hope of producing superior types of men by X-rays is pronounced futile by Dr. Halsey J. Bagg, of Memorial Hospital, New York City, an expert on heredity. Success in producing variations in fruit flies and mice by exposing the parents to the rays have led some experimenters to conclude that human evolution might be speeded up by their use. Dr. Bagg points out that the variations produced in the laboratory cannot be governed and that frequently they appear as deformities.

Rats and mice, for instance, exposed to the rays, produced offspring with one kidney missing in the first generation and with the kidneys wholly absent in the second generation after exposure.

Power Detectors—How They Work

Testing detector circuits with vacuum tube voltmeter in Popular Science Institute Laboratory.

The New Methods of Radio Reception Are Explained Here in Simple Terms—Why They Stop Distortion and Give Better Tone Quality

By ALFRED P. LANE

MUCH will be said this year about the "power detector" tube as an important feature of a modern radio receiver. And many persons will get the impression that a "power detector" is some sort of a super detector circuit, far more sensitive than the ordinary hookup. That—to put it broadly—is exactly what a power detector circuit is *not*

Considered in one way a detector tube is, perhaps, the most important tube in any radio receiver. In fact, the first vacuum tube receiver had only one tube, the detector tube. The tubes added later on, as the radio receiver reached a higher state of perfection, simply helped the detector tube to do a better job. Radio-frequency amplifier tubes were added to make the signal stronger before it reached the detector tube, and audio frequency amplifier tubes were added to take the output of the detector tube and bring it up to loudspeaker strength

The term "detector" really is a misnomer. The detector tube does not actually detect anything. It functions as a rectifier tube and the practical result of its operation is to disentangle the audible electrical frequencies carried by the radio wave from the inaudible high frequency carrier portion of the wave, and this result is accomplished mainly by rectification.

THE transmitter in the broadcast station produces a carrier wave which oscillates or vibrates at tremendously high frequency. Within the broadcast band of wave lengths the frequency may be from 1,500,000 to 550,000 cycles a second. The carrier wave is represented in the diagram at the top of Figure 1 Sounds produced in the broadcast studio are picked up by the microphone, translated into equivalent electrical vibrations, and then impressed on the carrier wave with the result shown in the central diagram.

Thus modulated by the audible frequencies, the carrier wave produces in your radio antenna equivalent, but very weak, electrical oscillations. These are amplified in the radio-frequency amplifier stages of the set and then fed to the detector tube. The detector tube suppresses current flowing in one direction and passes along the sound frequencies to the audio amplifier stages in the set, as shown in the bottom diagram of Figure 1, below.

Obviously the best detector tube is one that most completely performs its job of rectification and that passes the electrical equivalent of sound to the audio amplifier stages without distortion or additions of any kind.

The standard circuit which has been used for years to make a vacuum tube perform its function of detection or rectification includes the familiar grid condenser and grid leak. In this circuit, shown in Figure 2, the tube operates by what is known as the grid rectification method. It is the most sensitive radio detector circuit and is, therefore, the best

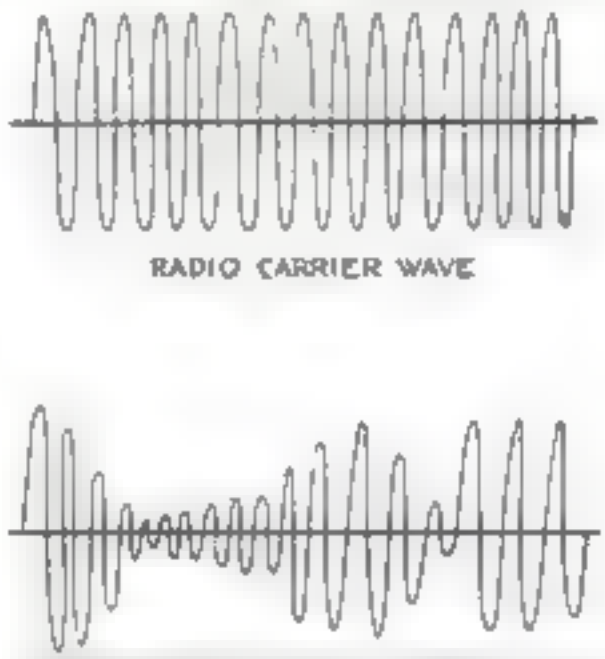


Fig. 1. Diagrammatic representations showing how radio signals are transmitted and detected.

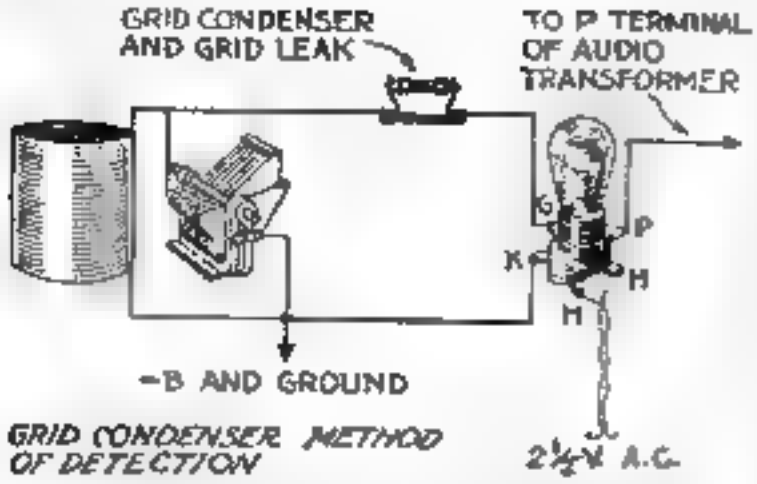
when only one tube is used in the receiver or when the radio-frequency amplification is of a relatively low order.

It has, however, two important disadvantages. First, there is a tendency to drop or lose the higher audible frequencies, and these frequencies are quite important because they include the higher overtones by which the tone of one musical instrument or voice is distinguished from that of another Second, it will not handle loud signals without distortion. If a powerful signal is fed to a detector tube connected in the grid condenser-grid leak circuit, the functioning becomes faulty, with the result that music becomes distorted and speech may be garbled almost beyond recognition.

BY CHANGING the electrical specifications of the grid leak and grid condenser it is possible partly to compensate for these disadvantages, but unfortunately such changes will greatly reduce the sensitiveness of the tube. For instance, it is possible to prevent the loss of the higher audible frequencies by reducing the capacity of the grid condenser. But this still further reduces the tubes' ability to handle a strong signal. Moreover, lowering the resistance of the grid leak to make it handle the stronger signals makes the tube very insensitive to weak signals.

Until the present year, therefore, radio listeners have lived between the devil of distortion and the deep sea of weak signals. However, recent advances in the design of radio frequency amplifier stages, and particularly the introduction of the new screen grid tubes, have made it possible to adopt a detector system which, although relatively insensitive, will handle any desired amount of power without distortion. The tremendous radio-frequency amplification now possible more than makes up for the lack of sensitiveness in the detector tube circuit.

THIS new and desirable "power detector circuit is technically known as the plate rectification method. In diagrammatic form it looks exactly like a radio-frequency amplifier circuit. The tube acts as a detector instead of as a radio frequency amplifier partly because of the difference in the ratio of the plate voltage to C bias, and partly because of the different arrangement of the plate circuit wherein a radio-frequency choke and by-



GRID CONDENSER METHOD OF DETECTION

Fig. 2. For years this has been the standard circuit for vacuum tube detection. Now new methods are replacing it.

pass condenser gets rid of the radio-frequency component of the wave.

Great power handling ability of the power detector circuit, coupled with the tremendous radio-frequency amplification, makes it possible to reduce the audio amplification. This cuts down the possibility of distortion in the audio amplifier circuit and, coupled with the more accurate detection of the power detector circuit, results in better tone quality from the loudspeaker.

In addition, cutting down the audio amplification materially reduces the A. C. hum so that the modern full electric radio receiver is practically hum-free even when working with a dynamic speaker that puts on the air the lower audio frequencies which include the A. C. hum.

Though A. C. hum may originate in many different ways in a full electric receiver, most of it comes from the detector stage, as this is the first tube in the receiver operating at audible frequency. Generally speaking, little hum originates in the radio-frequency stages of the set, since the radio-frequency stages do not operate at audible frequencies. Hum is caused by the radio-frequency stages only when they are over-biased or are being operated too close to the oscillation point.

PROBABLY you have noticed a distinct hum when you tune in a broadcasting station, particularly a powerful one, if the announcer is off the air for the moment. This hum is frequently attributed to the carrier wave of the broadcasting station. Actually it may be caused by one or the other, or perhaps both, of the conditions in the radio-frequency stages of such a receiver.

Any A. C. hum from the detector stage receives the full amplification of the audio amplifier stages before it reaches the loudspeaker. Consequently the greater the audio amplification, the louder will you hear any given amount of hum that comes from the detector tube. Reducing the amount of audio amplification automatically cuts down the hum. In many of the modern receivers the audio amplification is reduced by using lower ratio audio transformers. In some of them, the first audio stage is eliminated entirely and the power detector tube feeds directly to the last or power audio amplification stage. Both methods produce practically the same result, because the hum heard from the loudspeaker is determined by the degree to which the impulses from the detector tube are amplified.

Any grid condenser and grid leak detector circuit can be converted into a power detector circuit merely by removing or short-circuiting the grid condenser and grid leak, increasing the plate voltage, and arranging for a proper grid bias.

In the power detector circuit, if the plate voltage is 45 volts, the C bias should be 4½ volts. If the detector plate voltage is 90 volts the grid bias should be 9 volts, and if the detector plate voltage is 180 volts the grid bias voltage should be 18 volts. If the power detector is to be used with a two-stage audio amplifier it is not worth while to increase the detector plate voltage beyond 90, because a power detector tube operating on 90 volts on the plate with 9 volts C bias on the grid will handle more power than can be taken care of without distortion by a two-stage audio amplifier. However, if the power detector feeds directly into the power audio stage with the first audio stage eliminated it is desirable to use the higher voltage on the detector tube, that is, 180 volts on the plate, and 16 to 18 volts for C bias.

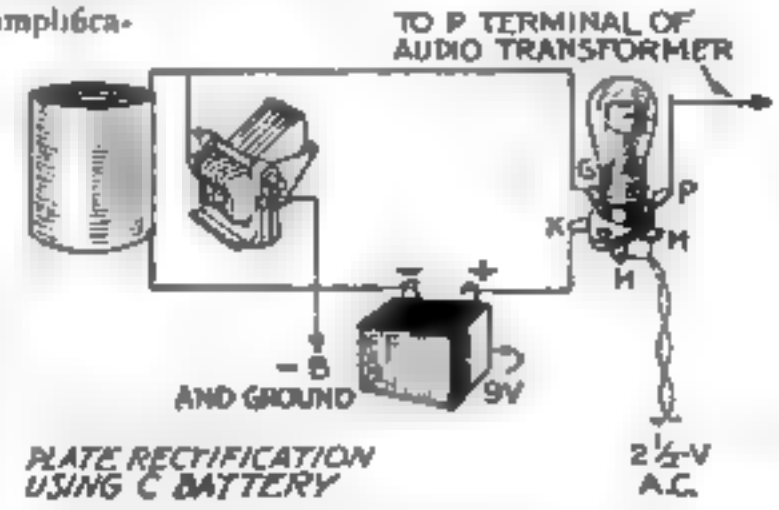


PLATE RECTIFICATION USING C BATTERY

Fig. 3. The best possible way of obtaining the C bias voltage for the power detector.

Figures 3, 4, and 5 show three forms of the power detector circuit. They are identical except in the method of obtaining the necessary C bias. All of these diagrams show the use of the UY-227 A. C. heater type tube. In Figure 3 the necessary C bias is obtained from a C battery. This is the best possible method, and we recommend it to those of our readers who wish the finest results. A bypass condenser should be connected across the leads to the C battery, unless the latter is mounted in the set.

FIGURE 3 also shows the correct method of operating a 201A storage battery tube in the power detector circuit. The plus terminal of the C battery is connected to the minus filament terminal of the tube socket, and minus B is, of course, connected as in the usual battery hookup—that is, either to plus A or minus A, instead of as shown in Figure 3.

Figure 4 shows the C bias obtained by the use of a high resistance variable resistor and a very large capacity filter condenser. This method will give as good results as can be obtained from the dry cell C battery method, only if a very large condenser is used and if the B eliminator has a very efficient filter circuit.

Figure 5 shows the C bias obtained by the use of a grid biasing resistance in exactly the same manner as the grid bias is obtained in the audio and radio amplifier circuits. Note that 50,000 ohms resistance is used. This resistance will be approximately correct regardless of the plate voltage applied. Increasing the plate voltage will increase the plate current flowing through the grid biasing resistor, and consequently result in an increase in the C bias voltage. This method of obtaining the C bias in the power detector circuit is used extensively in commercial sets and gives satisfactory results.

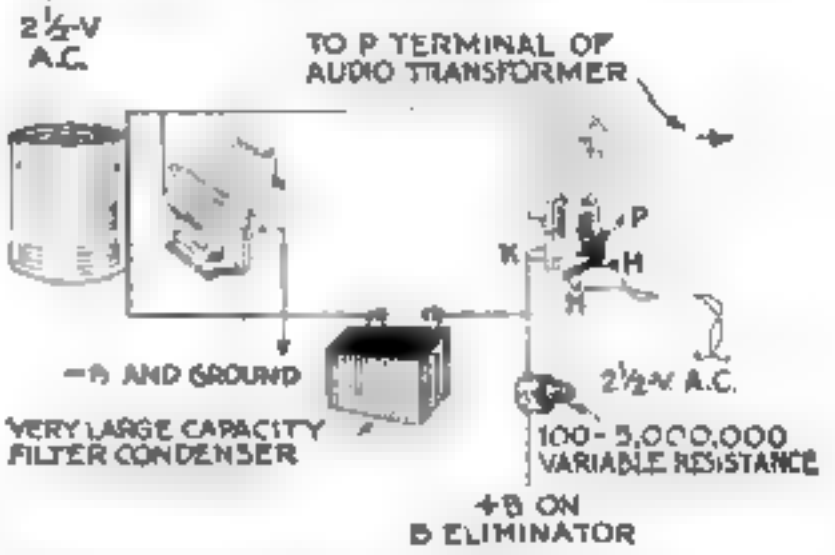


PLATE RECTIFICATION OBTAINING GRID BIASING VOLTAGE FROM B ELIMINATOR CIRCUIT

Fig. 4. To obtain hum-free results with this method, it is necessary in building to use a filter condenser of very large capacity.

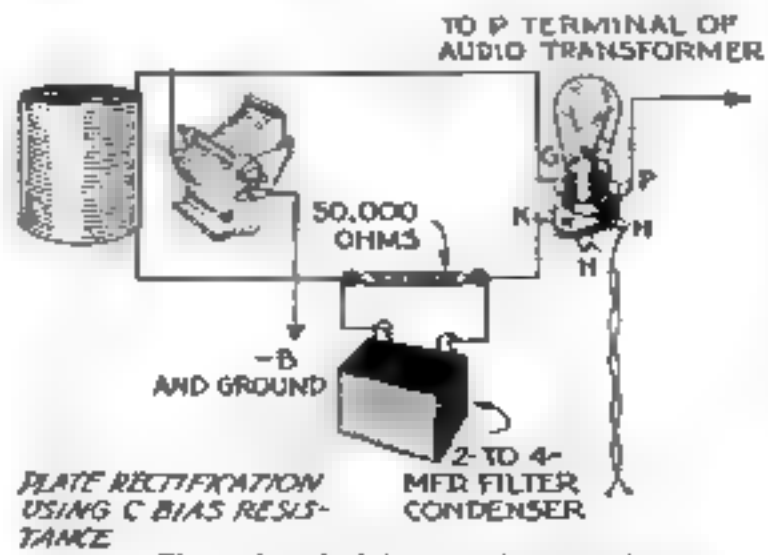


PLATE RECTIFICATION USING C BIAS RESISTANCE

Fig. 5. A method that is used extensively in commercial receivers. It gives satisfactory results.

WHEN the C bias is obtained in this way, the stronger the carrier wave, the less effective is the tube as a detector. This means that there will be less difference in the volume between a powerful, local station and a distant, weak station, than is the case when the C bias is obtained from a separate battery. Since, however, it is usually necessary in any case to turn down the volume control on local stations, this peculiarity is of minor importance.

Useful Hints for the Radio Fan

Special Pliers Simplify Wiring

Three Handy Tools for Set Builders—New Standards for Measuring Sensitiveness -Simple Ways to Test Voltage

IN WORKING on a radio receiver, exasperating jobs that are almost impossible to get at with bare fingers become easy if the fingers are supplemented with proper tools. The illustration on this page shows three of the most useful tools in radio. At the left is a pair of duck-nosed or flat-nosed pliers designed for reaching into a tight place to hold a short piece of wire firmly. Incidentally these pliers are not sensitive to temperature, so that in making a solder joint a wire can be held at a point close to the soldering copper. Pliers of this type also make it easy to reach in and bend the end of a wire for a joint, or to recover a nut, bolt, or other small part that has fallen into an inaccessible part of the set.

Left to right. Duck-nosed pliers to grasp where fingers cannot reach; special wire-cutting pliers useful also for stripping insulation; round-nosed pliers for bending loops.

The special pliers shown in the center are designed solely to cut wire. The cutting angle and the size and shape of the jaws are such that they can be used where the ordinary heavy wire-cutting pliers will not reach the work. If, for instance, it becomes necessary to solder a short piece of wire, say an inch long, between two terminals that are close together, a long piece of wire can be used to make the solder joints, and then with these pliers the excess wire can be cut off cleanly.

Pliers of this type also are extremely useful in stripping the insulation from the flexible enameled fabric and rubber-insulated wire popular for radio work. With practice, a ring may be pinched around the insulation at the point where it is to be parted, then the insulation may be stripped off. With a knife the job would take three or four times as long.

The small round-nosed pliers at the right are useful in forming a neat loop in the end of a stiff wire to fit over a binding post or in making neat rectangular bends. They are handy also for holding work and in various assembling operations.

Measuring Sensitiveness

IN THE early days of radio, manufacturers of receivers, as well as enthusiastic home constructors, made all sorts of absurd claims for the sensitiveness and distance-getting ability of their sets. Within the last year, however, radio and electrical engineering societies have worked out a standard method of testing the sensitiveness of a receiver. It is now possible to determine exactly how sensitive any set will be under any given conditions, assuming, of course, that these conditions are known.

The strength of radio signals produced in any given location by a broadcasting station is measured in microvolts per meter. A microvolt is the millionth part of a volt. If, for instance, it is found that a certain station produces, in a certain locality, a field strength of ten microvolts per meter, it means simply that the radio signal brought in by an antenna in that location will have a strength of ten microvolts for each meter of height of the antenna. Thus, if a receiver is rated at ten microvolts per meter it means that, with a field strength of ten microvolts per meter, it will give a standard loudspeaker signal. Another receiver capable of giving a standard loudspeaker signal with a field strength of only five microvolts per meter would be twice as sensitive as the first set, or if it requires twenty microvolts per meter to produce a standard loudspeaker signal the receiver would be only half as sensitive as the first.

The sensitivity of modern receivers is improving. The average radio receiver of a year or two ago required a field strength of approximately thirty microvolts per meter. The average of this year's higher grade receivers will give a standard loudspeaker signal when the field strength is slightly less than ten microvolts per meter.

A B C's of Radio

THE tuning circuit in a radio receiver always consists of electrical inductance in the form of a coil of wire connected across electrical capacity in the form of a variable condenser. The wave length or frequency to which the circuit is tuned is governed both by the electrical inductance and by the electrical capacity.

Increasing the inductance, which means adding turns of wire to the coil, tunes the circuit to a longer wave length or a lower frequency. Increasing the capacity, which means engaging the plates of the variable condenser to a greater degree, has the same result. Reversing either of these operations—that is, reducing the inductance by removing turns from the coil or reducing the capacity by disengaging the plates of the condensers—results in tuning the circuit to a shorter wave length or a higher frequency.

Testing High Voltages

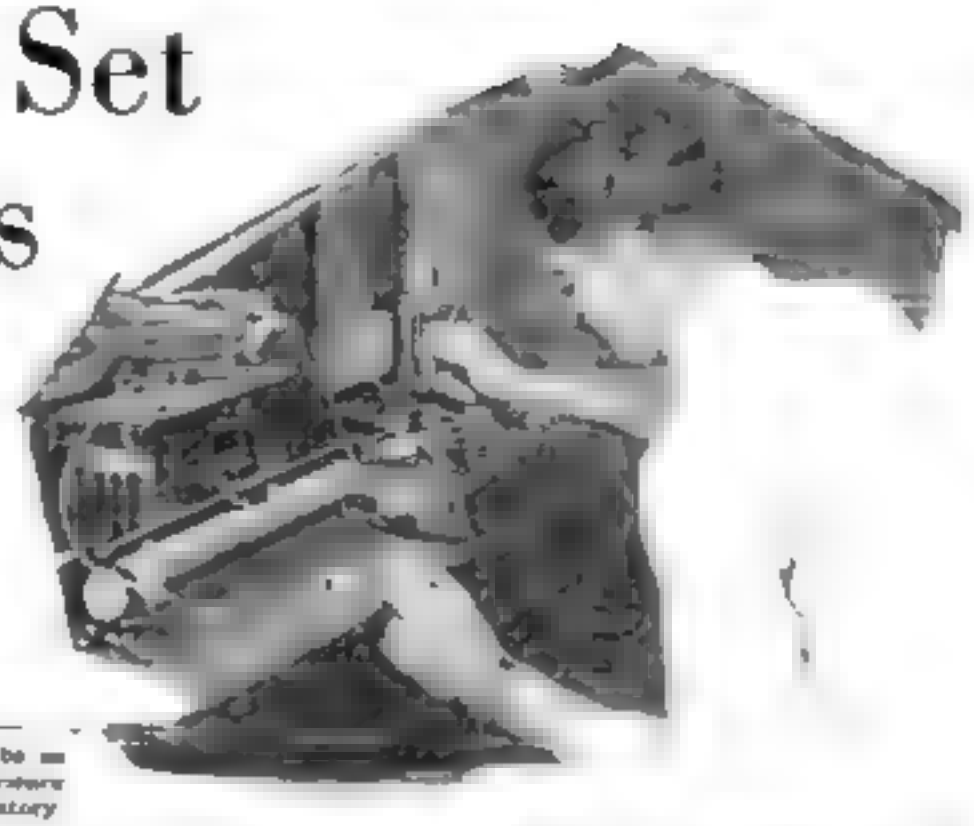
MANY radio experimenters have voltmeters designed for testing B eliminators having a maximum reading of not more than 250 volts. Such a meter, cannot, of course, be used directly to measure voltages higher than the maximum for which it is rated and consequently would seem to be almost useless in testing voltages in a circuit using 210 or 250 power tubes. Such tests can be made accurately, however, by measuring the voltages across the various steps of the fixed resistance and then adding these voltages together to get the total. Measure from the minus B end of the resistance to the point that gives a reading somewhere near the maximum of the meter. Then, with the minus end of the meter connected at the latter point, connect the plus end of the meter to the plus end of the resistance.

With a low voltage meter it is possible also to determine whether the proper plate current is flowing in the power tube. First determine the plate current as already outlined and then measure the voltage developed across the grid biasing resistance. The value of this voltage is determined by the amount of plate current flowing. If both the plate current and the grid biasing voltage are correct it is absolutely certain that the plate current flow also is correct.

Guarding the Set from Blow-outs

A Few Simple Precautions Save Radio Apparatus from Short Circuits and Fires

By JOHN CARR



Testing flashlight bulbs as fuses in the Popular Science Institute radio laboratory

ELECTRIC current is an obedient and tireless worker when properly controlled, but if a breakdown permits it to flow outside its normal path valuable apparatus may be ruined in the twinkling of an eye

A radio receiver may operate smoothly and without trouble for months or even years and then, without warning, insulation may give way and a short circuit may turn valuable apparatus into smoking scrap metal, perhaps setting fire to the whole set.

Such accidents never can happen to receivers properly protected against short circuits. Modern factory-built receivers are so protected. Any excessive flow of current in the circuits immediately blows a protecting fuse and the current is shut off before it can cause damage.

The operation of a fuse is based on the principle that a chain is no stronger than its weakest link. The current-carrying capacity of the fuse is so chosen that it will be the weakest link in the circuit When excessive current flows, the fuse will be burned away, opening the circuit before any other wire is affected

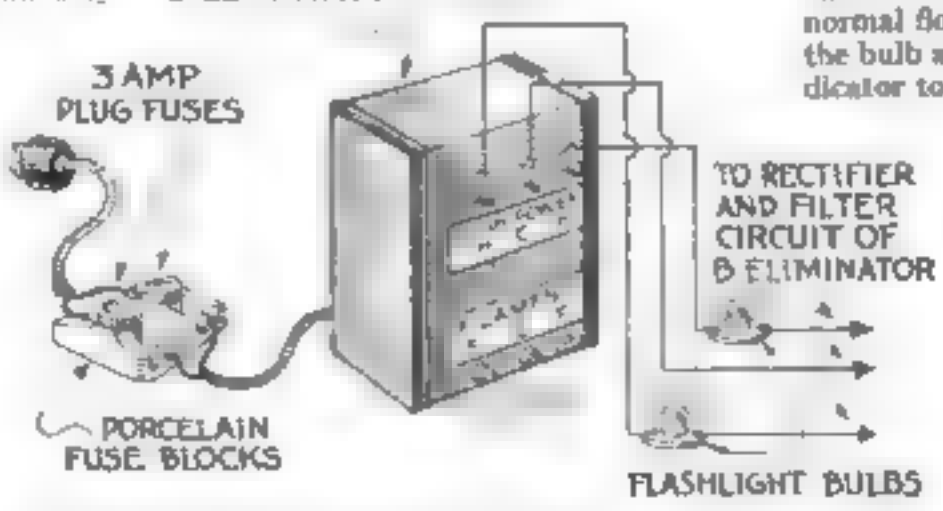
THE fuse in a commercially built receiver usually is connected in the wire leading to the primary winding of the power transformer. This is the point at which the current enters the set, and the capacity of the fuse is so chosen that it will pass all of the current that can be used in the set under normal operating conditions. If the filament of a rectifier tube burns out and the end of the filament falls over and short circuits against the plate, a large flow of current is permitted in the secondary circuit of the power transformer. This flow can only be produced by an increase in the flow of current in the primary circuit and the fuse blows at once, shutting off the current. Or it may be that one of the filter condensers short circuits. In that case the flow of current is greatly increased, with the same result

It is entirely practicable to protect any home-built receiver or power amplifier unit against a serious burn-out. And it pays. A study of the current flow possibilities will show how to do it

Any electric receiver or power amplifier unit includes what is known as the primary circuit This consists of one or more primary windings, the switch that turns the current on and off and the cord which plugs into the electric light socket Primary windings are so thoroughly insulated from all other circuits in the receiver that there is little chance of a short circuit between them. If a short circuit occurs between the cord and the metal frame of the set or the grounded core of the transformer, the fuse in the house lighting circuit will blow before damage is done, provided, of course, that the fuse is of low current-carrying capacity If however the receiver is used on a line carrying considerable normal load and the current-carrying capacity of the fuse is too high, a fire will be started inside of the set before the line fuse blows

TROUBLE of this kind can be prevented by inserting a fuse block in the lead wire that goes to the socket, as shown in the illustration. Because it is impossible to tell which side of the 110-volt lighting line is grounded, it is desirable to use a fuse block containing two fuses, so that both wires in the drop cord will be protected. Use no larger than 3-ampere plug fuses.

In a battery-operated receiver the use of a 3-ampere fuse block between the storage A battery and the set is desirable The fuse block should be connected close to the storage battery to protect against short circuit in the wires leading to the set, as well as possible short circuits in the filament wiring.



This diagram shows how to use flashlight bulbs and plug fuses in order to protect the B eliminator circuits of a radio receiver from costly burn-outs.

The most effective fuse for use in the high voltage B eliminator circuit or power amplifier unit is the flashlight bulb. Tests were conducted recently in the Popular Science Institute of Standards radio laboratory to determine the current-carrying capacity under normal load of all types of flashlight bulbs, and also the current flow at which the filament of each burned out. The common types of flashlight bulbs are rated at 2.2 volts, 2.5 volts 3.8 volts, and 6.2 volts, but the current-carrying capacity of these various bulbs under normal load was found nearly uniform, regardless of the voltage The 2.2-volt bulb carried .26 amperes and the other bulbs varied between this and .30 amperes. It is safe, therefore, to use any standard flashlight bulb of any standard voltage rating in a circuit carrying not more than 250 milliamperes. All of the bulbs burned out at current flows ranging between .34 amperes and .49 amperes.

THE chief advantages of a flashlight bulb as a fuse are that the burn-out occurs almost instantaneously, there is no arcing effect, and the wiring, therefore, is completely protected. The illustration shows the ideal method of using flashlight bulbs on the high voltage leads from the transformer in a B power unit. If a rectifier tube burns out and the filament short circuits against the plate, the flashlight bulb will blow out instantaneously and no damage will be done. As the normal flow of current will make it glow, the bulb also serves the purpose of an indicator to show that the current is flowing in the circuit

The owner of a battery operated receiver will find that a flashlight bulb connected in each B lead to the set will prevent his batteries becoming run down due to a short circuit, and also protect the filaments of his radio tubes if by accident the B wire is connected to the set in the wrong position, that is, if the plus B wire is connected to the plus A binding post.

A New Slant on House Painting

The house the Kerseys plan to build. "A too good or a poor paint job." By courtesy The Home Guild of America, Architects.

WHY does the paint on one house go to pieces in a few months, while on another it lasts for years? In this article an expert gives the answer. For free advice on your painting problems, write to the Building Service, Popular Science Institute, 381 Fourth Avenue, New York City.

By ROGER B. WHITMAN

TO BOB KERSEY, paint was merely for decoration, or to freshen things when they were shabby. That there was more to it first occurred to him when he found his friend, Tom Sands, all worked up because something was the matter with the paint on his garage.

"Look at that," growled Tom. "It's coming off like white wash!"

"Well," inquired Bob innocently, "can't you have it painted again?"

Tom glared at him. "Of course I can and that's what I've got to do, hang it. I paid $50 for that job only eight months ago, and it should have lasted four years. Now I've got to pay another $50 to have it done over again. Suppose it was your paint that had gone bad, how'd you feel?"

Bob's interest blazed up. "Say," he said, "you hit me there. There'll be a lot of paint on that house I'm going to build. What made this paint come off, anyway?"

"Search me, but I'm going to find out. I called up the man who sold it to me, and he said he'd come out."

Half an hour later the paint man arrived. Tom was none too cordial. "I suppose you'll blame everything but the paint," he said with heavy sarcasm.

"You're right," answered the paint dealer. "That paint is as good as there is. I've been handling it for years. Did you put it on yourself?"

"No, my odd-job man did it. He said that he'd painted before, so I told him to go to it. He's no expert, but I can't see that it takes much brain to swing a paint brush."

"BETTER change your mind on that, Mr. Sands; this job's proof of it. My books show that you bought the paint in October. Wasn't there a rainy spell about that time?"

"There sure was. It began to rain the day I bought the paint, and it rained for a week. I wanted to get the job done before cold weather came, and the man started as soon as it cleared."

"Yes, and there's one of your troubles. If he'd been a painter he'd have known better than to put paint on wet wood, he'd have waited at least two days for it to dry out. When you put paint on dry wood it strikes into the pores and hardens with a grip that holds it there; but with the pores as full of water as they were when that bright man of yours went to work, the paint just lay on the surface.

This photograph shows what happens when woodwork is exposed to the weather without paint protection. It very quickly decays.

And here's another thing. Was the paint [illegible] can?"

"Why—I don't know. But why not? It was ready to use, wasn't it?"

"Yes, for the second coat, but for the first it should have been thinned. It would have worked into the pores better and taken a tighter grip. The priming coat—the first coat, that is—should always be thinned with turpentine when the wood is hard and sappy, and with linseed oil when it's soft and spongy. That first coat is the foundation for the whole job, for it has to hold the other coats. As it came from the can the paint was too thick to strike in as it should, and when the sun began to pull the moisture out of the wood the paint came with it."

The evidence was so clear that there was nothing for Sands to do but write off the loss and charge it to experience. The episode so impressed Bob Kersey, however, that he lost no time in telling his architect about it.

"THAT'S what you get when you do a paint job on the cheap," was the architect's comment. "It isn't only the way the paint is put on, either; the quality of the paint counts, too. Some paints will last for years and others will begin to go bad in six months. The real purpose of paint is to protect the material underneath from rotting and going to pieces. You know what happens when you put iron or bare wood out in the weather; the iron will rust, and the wood will split and warp and rot from being soaked and dried, and from the freezing of absorbed water that tears its fibers. Fill the pores with paint so that water can't get in, and they'll last almost forever. The more carefully the paint is put on, the more thoroughly the pores will be filled, and the better the paint, the longer it will last. If there's any one place where you save money by spending it, it's on a paint job. See what your friend Sands got. With good work, his $50 paint job would have lasted four years, making the cost $12.50 a year. If he keeps on the way he's started, though, it will cost $50 a year.

"If you want to learn something about paint, go and see Jim Martin. He's been a painter all his life and knows more about it than anyone around here."

Bob dropped in on Martin one after-

noon, and found him breaking into a keg of what looked like white paste. "What's that?" he asked. "White lead," the painter answered. "I'm just going to mix up some paint."

"I never saw paint as thick as that."

"Sure, young man; this isn't paint yet, it's only the beginning of it. Got to put in the oil and turps and drier, and then I'll have it."

"Say, I'd like to know something about it," said Bob. "I was telling my architect about the paint I saw coming off a garage. What is it about paint that makes it good or bad?"

JIM beamed with pleasure at having an auditor. "The materials; same as anything else. You can't make a good cake with old eggs and poor flour, and you can't make good paint if the oil and the other parts aren't right. You see, it begins with linseed oil. Spread that on anything and it hardens into a waterproof film. There's no body to it, though, and it wouldn't last long; so you mix it with white lead, zinc oxide, and other things that'll hide the surface you spread it on, and that'll let you brush it. If you use good stuff and mix it right, and do a good job of painting, it'll be years before weather can get through it, but with no-good oil and not enough of the parts that count, it'll begin to go as soon as you put it on.

"When you buy cheap paint you'll be doing the job over again in a year or so, and that's what runs up the cost. I did a job last week that took $35 worth of paint, and the labor of putting it on cost $60. That was $95 for the job, and it'll last a good five years; $19 a year. The owner could have saved $1.25 a gallon on the paint, and the job would have looked just as well when it was new, but in two years it would be gone and he'd have it to do all over again. Cheap paint costs as much to put on as good paint; so the job would have cost $72.50 instead of $95. But doing it over in two years would have been $36.25 a year, and that's pretty expensive.

"CHEAP paint is the worst economy I know. It doesn't last and it won't go so far; you have to use more of it. I've tried that out and I know. A couple of years ago I had to paint my barn. On one side I used the best paint I could make. I figured that it cost $3.50 a gallon, and it took five gallons. The paint I used on the other side cost $2.25 a gallon, and I give you my word that I had to use eight gallons of it. So it took $18 worth of cheap paint to go as far as $17.50 worth of good paint, and I had the extra work of putting on three more gallons."

"Why do you mix your own paint when you can get it in cans?"

"Habit, I guess. And I can get just what I want. But you see, I'm an old hand at it. I'd advise anyone else to buy it ready mixed, providing they know what they're buying. I've seen ready mixed paint where the liquid part tested twenty-five percent water, and with only one quarter of the linseed oil it should have had, and poor oil at that. The cheapest paint is the one that costs most, because it has better materials, better mixed. It goes further and lasts longer. But how is it you're so much interested in paint?"

"Well, there'll be a lot of painting in a house I plan to build, and I want to find out about it before I start. I'd like you to do the job, and we might as well begin to talk about it. Here are the plans."

MARTIN looked them over. "Nice house," he said. "Too good to do a poor job on. I warn you, there'll be painters who will paint it for less money than I will, but I'll guarantee to give you a job that'll last."

"But what will you do that the other fellows won't?" Bob inquired.

"Make the paint suit the work, for one thing, and put it on exactly right for another. Every knot and sappy place in the boards will get a good coat of shellac to keep the sap from staining the paint. Ever see a knot showing through paint? That's what I mean; the sap wasn't sealed in. There'll be a priming coat mixed for the kind of wood it goes on, and when it's dry, the nail holes and cracks will be filled with whiting and white lead putty. The second coat will be mixed with turps and oil half-and-half, and the third coat'll be mostly oil. That's the kind of a job that lasts. How are you going to finish the inside?"

"Wall paper in the bedrooms and the dining room, and panels of fancy paper in the living room, with the rest of the walls painted. The library is to be paneled oak, everything else in the house painted."

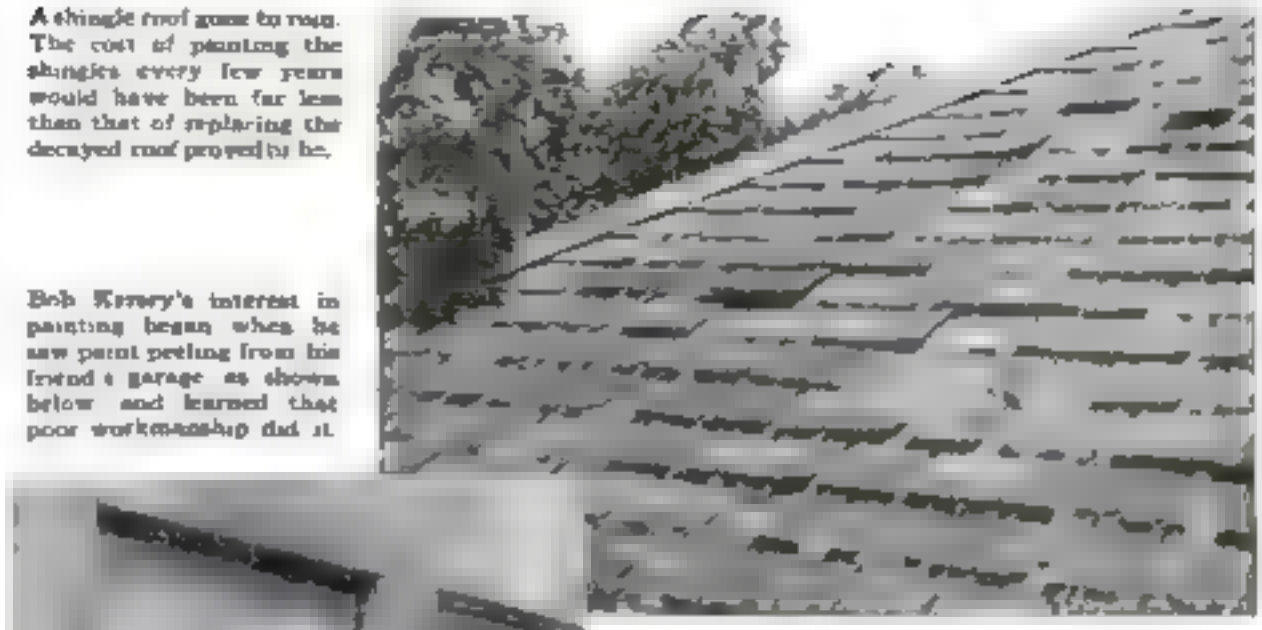
"PAINT on the trim and doors, eh? If you give me the job, I'll paint the back of the trim before it goes on; give it a good priming coat."

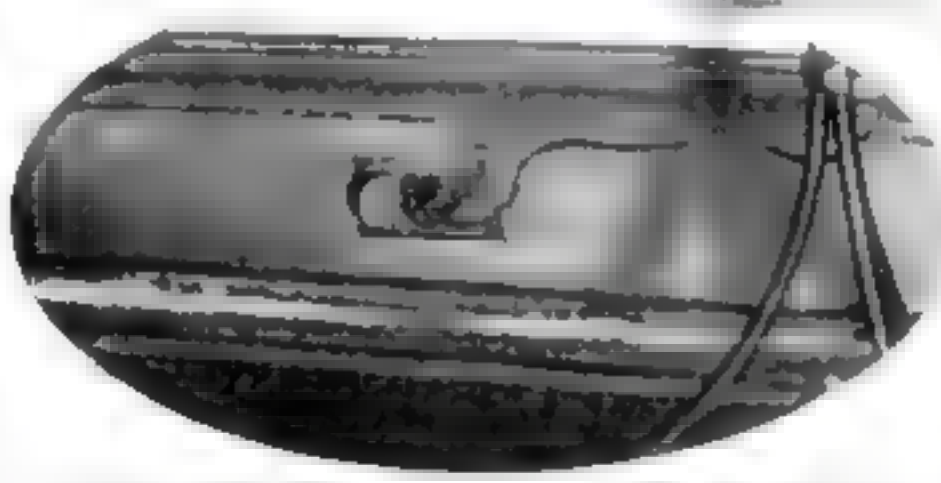
"I don't get you." Bob was puzzled. "You mean that you will paint the back of the woodwork around the doors and windows? What's the good of that? Nobody sees it."

"Maybe not but I'd paint it, and the backs of the baseboards and the moldings, too. You see, if you leave them bare they'll absorb moisture in damp weather and give it up in dry, and with swelling and shrinking you'll get open joints and cracks. But if they're sealed all over they'll stay put. The edges of all the window sash will (Continued on page 147)

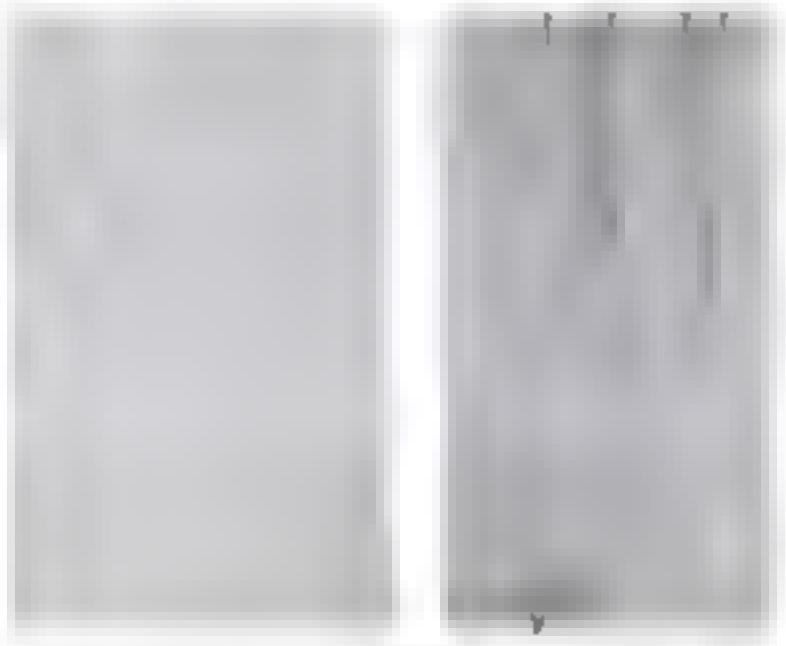
A shingle roof gone to ruin. The cost of painting the shingles every few years would have been far less than that of replacing the decayed roof proved to be.

Bob Kenny's interest in painting began when he saw paint peeling from his friend's garage as shown below and learned that poor workmanship did it





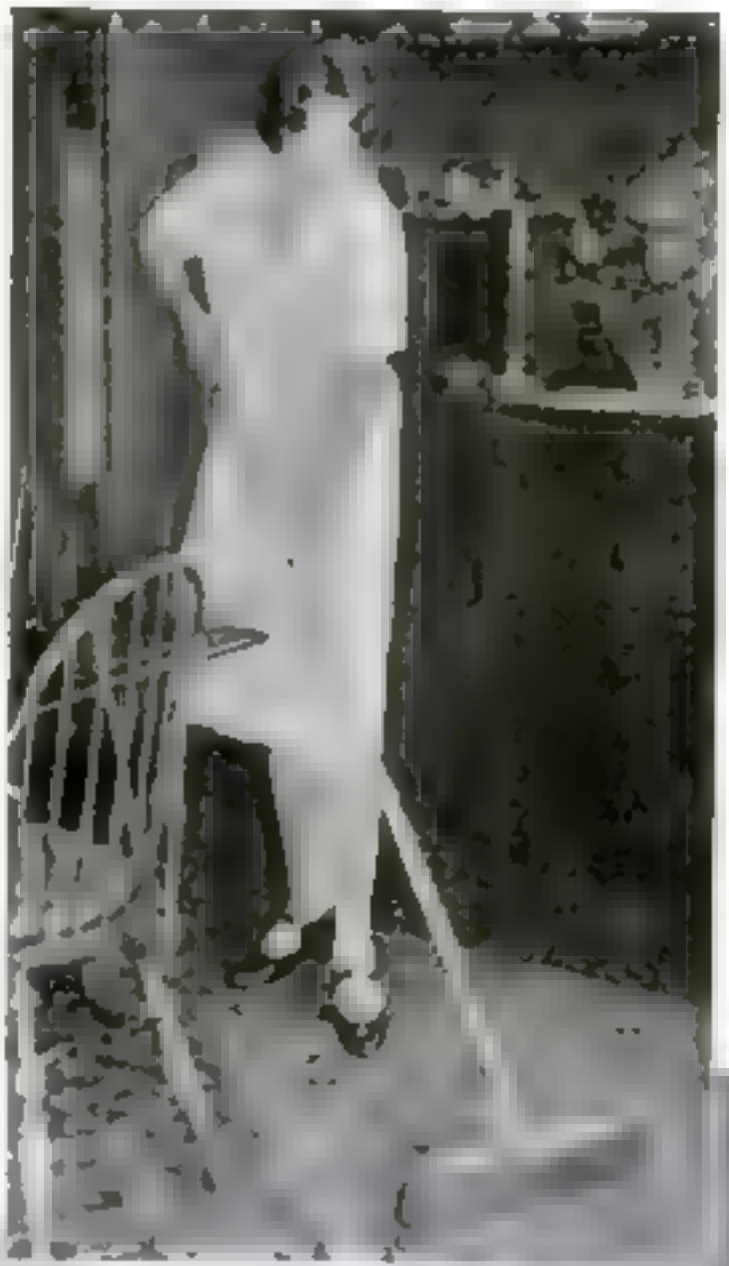
Paint is here shown peeling from a baseboard. Such failure may be due quite as much to poor application as to low quality of the paint.



Three months' exposure had no effect on the high quality paint on left panel, but ruined the poor paint at right

Latest Helps for the Homemaker

Electric appliance cords are adjusted to any length desired with this handy device, which accommodates wires of four sizes.



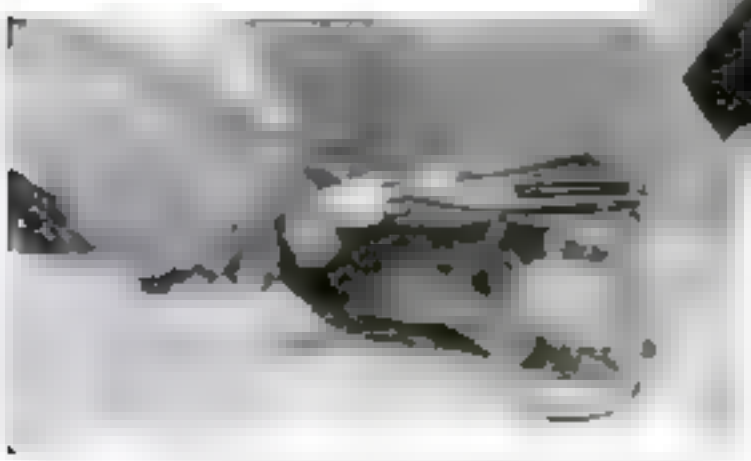
Dipping a cloth in the gas tank to remove spots from clothes is just one job for these novel tongs, which can reach into small necked bottles, hold nuts for overhead driving, or lift off the hot covers from kettles.

Rubber bumpers on the edge of the push broom at right prevent marring of furniture. The handle is reversible, permitting the use of both sides of bristles. It is twice the width of an ordinary broom.

The latest in clothespins are unbreakable ones of rustless metal, said to hold clothes in a bulldog grip and to last for years. Small and easy to handle, they will not soil nor tear the finmunt of garments.

This new shoe-shining device works like an automobile grease gun and is very handy. A twist of the top forces cream from its hollow handle onto a swivel brush, which is then used to polish the shoe

The bean stringer above clamps to the table. Running the shell along the knife slits it open and deposits the string in a bowl that is held underneath.



A new jar opener of hardened steel, with enameled handle, will tighten or loosen screw covers on jars or bottles of any size. The two raised arms of the instrument fit so snugly on the cover that no heavy pressure is needed to remove it, and there is no possibility of breaking the container.

The egg cutter at the right slices hard-boiled eggs for salad making. One side of the device splits the egg lengthwise, while the other cuts it radially.

What Inventors Are Doing to Lighten Household Chores and Add New Conveniences in Every Room

The day's milk is protected from heat and cold by a new outdoor "safe," constructed of insulating fiber. The box will hold three bottles so snugly that there is no danger of tipping or spilling.

A removable heating compartment that can be used as a bathroom heater is a feature of the electric laundry dryer above. It is used to dry lingerie, and garments that commercial laundries might injure.

The breeze from the whirling blades of this new electric fan is deflected horizontally in all directions by the rose shaped top. You can't catch cold from its breeze the maker claims, as there is no direct draft playing upon you wherever you are.

Washstand faucet left becomes drinking fountain when nozzle is reversed above. For washing, hot and cold water can be mixed in any proportions, as required.

The portable ironing board for travelers shown above is only eighteen inches long when folded. It will stand at any desired height when opened, and has a heating element which fits a lamp socket. A rest is provided for the iron.

When not being used to warm a room, the electric heater above is turned up and makes a convenient stove, as shown at the left.

The device at the left is a warmer for the feet of people who prefer sleeping in bed. After standing the sheets, insert the warmer and the result they will be warm and cozy for the

Glimpses of Unusual Men

W. B. Coleman, shown holding quail eggs and baby quail, breeds the birds scientifically to save them from extinction.

A Breeder of Quail

NOT long ago W. B. Coleman left the employ of the state of Virginia after serving since 1919 as official breeder of quail. In those ten years, Coleman raised more than 20,000 bobwhites on the first and largest farm in the world devoted to the breeding of those shy, wild game birds in captivity. Last season 8,448 quail were hatched, 5,000 of which were grown. All of those birds, as well as their 15,000 predecessors, were liberated on the Virginia game sanctuaries.

Coleman has reduced the breeding of quail to a science and an art. For many years he has studied their habits of feeding and propagating and has carried on researches to find means of protecting them from vermin, snakes, and birds of prey.

As in many other cases of specialization, Coleman's absorbing interest in quail was aroused by accident, and at first he did not dream that raising the birds would come to be his life work. It all began some sixteen years ago, when he was recovering from a severe injury on his family's tobacco farm in Amelia County, Va. During his convalescence, he reverted to a pastime of his boyhood—hunting bobwhite. But all he could find in a long day's tramp would be about six or eight coveys of the birds compared to twenty-five or thirty in a similar period when he was a lad.

It was plain that the quail were disappearing. Although the state game laws protected them by providing a short hunting season and a bag limit, as well as prohibiting their sale for food and restricting shipment, the increasing number of hunters, together with the depredations of hawks, owls, crows, snakes, and other natural enemies, proved too much for them.

Colonel E. H. R. Green, wealthy son of Hetty Green. Airships are his latest hobby.

Something, Coleman felt, ought to be done, and he had no sooner recovered from his illness than he set about doing it. That year he raised sixty quail on the tobacco farm by setting under bantam hens eggs from six pair of wild quail he had trapped. In the fall, he exhibited nineteen of them, with their chicken foster mother, at the Virginia State Fair. The exhibit attracted wide-spread attention among sportsmen and bird-lovers throughout the South. As a result, Coleman was given the job of raising quail on the 66,000-acre game preserve of the Okeetee Club of Switzerland, S. C., one of the most exclusive sportsmen's organizations in the country, where he carried on his work with marked success for the next five years.

Following the severe winter of 1917-18, when thousands of quail died of starvation, the Virginia State Game Department placed an order for 4,000 Mexican birds. The shipment did not arrive, and it was suggested that the state raise its own bobwhite. The department heads were doubtful of the plan's feasibility and were at a loss as to whom to select for the task. M. D. Hart, now Virginia Game Commissioner, was familiar with Coleman's experiments and proposed him for the job.

Coleman first selected a location for the farm, which he established at Boulevard, about twenty-five miles southeast of Richmond, on the banks of the Chickahominy River, where, according to legend, the Indian Princess Pocahontas saved the life of Captain John Smith. Then pens and breeding houses were built under his direction and the work was started.

COLEMAN was responsible for several innovations in quail breeding, among them the use of the incubator and the brooder, and of the cock bird to mother the young. But probably the most remarkable thing he did was to change the bobwhite from a monogamous into a polygamous creature. In the wild state, the male quail has only one mate. Coleman introduced the customs of the henhouse among the birds, mating a dozen hens with four cocks. The new system proved a great success for, while the individual hens laid fewer eggs under the changed conditions, the total of fertile eggs obtained was considerably larger.

At present, Coleman is manager of the Coleman Experimental Quail Farm near Richmond. Here he devotes his efforts mainly to devising methods whereby quail may be bred in captivity at the lowest possible cost.

An Explorer-Merchant

WHEN members of the Morden-Graves expedition of the American Museum of Natural History sailed for northern Asia in search of the long-haired tiger of the Amur River jungles, they took with them equipment from a little shop in the shadow of the Woolworth Building in New York City.

Here, amid the bustle of the Manhattan money marts, are sold the tools of romance and adventure. Men whose names are synonymous with the thrill of exploration, among them Commander Byrd, Sir Hubert Wilkins, Captain Dyott, and the late Theodore Roosevelt and his sons, Theodore and Kermit, have visited the modest store before starting on their treks into the unknown. Its shelves and show cases contain parkas and sleeping bags to withstand the cutting cold of the Arctic; waterproofed tents to keep out torrential tropic rains; netting to protect the wanderer against the bite of venomous insects; dog sleds and snowshoes to take the traveler far into the frozen spaces of Polar regions; scientific instruments to guide him through trackless wastes of land, ice, or water; knives and guns to hunt wild beasts and ward off hostile natives.

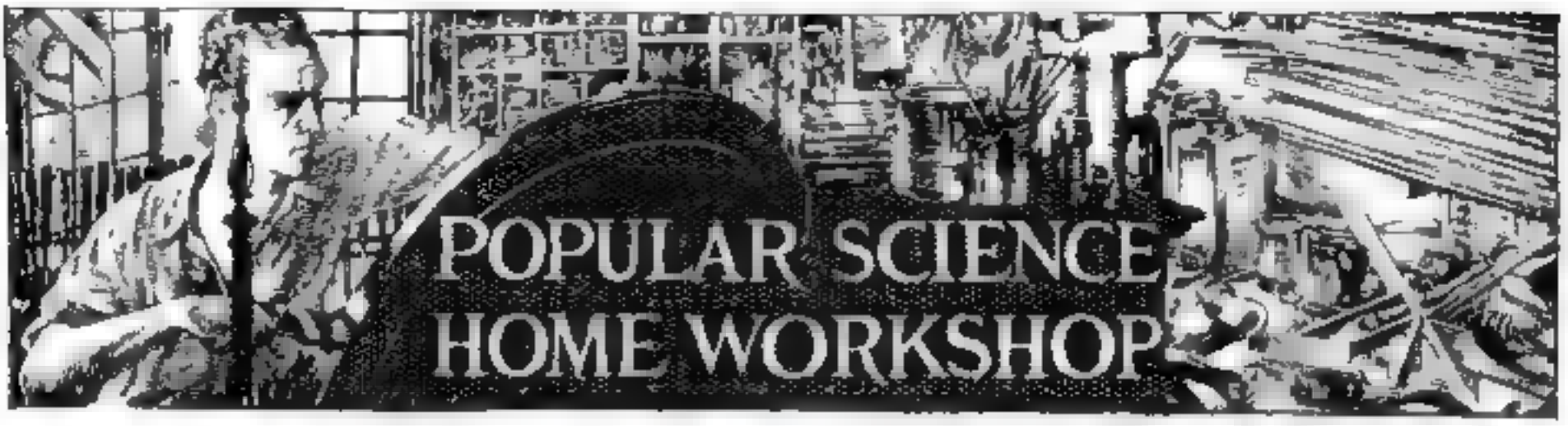
But the men—and a few women, too—who call at this intriguing place do so not merely to be outfitted. They seek also valuable counsel. For the unique establishment is conducted by a man who is himself an explorer. He is Major Anthony Fiala, who participated in two North Pole expeditions, one of which he commanded, and who chartered the Papagaio, Juruena, and Tapajos Rivers with the late Theodore Roosevelt on the famous "River of Doubt" expedition in Brazil.

Major Anthony Fiala, "the explorers' quartermaster," himself an adventurer.

It is difficult to imagine that the mild-mannered, gray-haired man with twinkling eyes and the patient, thoughtful expression of a scholar has ever been very far from his old-fashioned roll-top desk in the little New York shop. Yet he has had a career studded with thrilling experiences that rival the most romantic fiction.

Until he was twenty-nine, Fiala had led the

(Continued on page 147)



Linoleum Carving—A New Craft

How to Cut Designs for Decorating Furniture in a Material Much Easier to Work Than Wood

By DOUGLAS LEECHMAN

MOST men who own a selection of chisels and gouges have promised themselves that they would do some wood carving "some time," but the closer they get to the job the bigger it looks. Linoleum carving—a new and fascinating craft—offers an excellent solution.

Linoleum is much cheaper than wood, it can be had in pieces of almost any size, it is easily and quickly worked, it does not warp, and, if a piece is spoiled, the loss is not very serious in either time or money. In wood carving the amateur can at first do relatively little, but in linoleum his early efforts are practically certain to result in presentable and highly decorative work.

The limitations of the material practically confine the craftsman to low relief carving, but the possible applications are numerous. Tiles, sides and tops of boxes, bookends, push panels for doors (which should be heavily varnished so that they may be washed), teapot stands (which are better carved but unpainted), vase stands with a decorated border showing round the foot of the vase, and even elaborate scenic and other wall plaques may be undertaken.

Furniture, however, offers perhaps the richest field. Inset panels for cupboard doors, the sides and tops of bookcases, magazine racks, the tops of occasional tables, door panels, drawer fronts, picture frames, ash tray stands, and many others suggest themselves as suitable for this form of appliqué decoration. Incidentally, an appropriately carved piece of linoleum would make a novel panel for a homemade radio set.

Now that furniture in modernistic shapes and colors has become so much the vogue, there is ample opportunity to apply suitable and effective decoration in this type of carving. When an understanding of the possibilities of this new craft is gained, there will be no difficulty in turning out work of striking appearance and considerable intrinsic value.

It is, of course, evident that the Northwest Coast Indian designs in the illustrations are given merely as examples, this type of art being particularly suitable to the work. The craftsman is free to develop his own ideas along any line which he may select, and the scope offered is wide.

The materials needed are of the simplest. A piece of linoleum of the required size, a sharp knife, a chisel, and some oil paints are all that you will find absolutely essential. A heavy grade of good quality linoleum is the most suitable, and it may be of any color. Cuttings can usually be had from furniture stores, and if these are not available, a square yard may be purchased for one's first attempt.

Linoleum carving, reproduced directly from a panel 5 by 8 in. cut and colored by the author.

ANY sharp knife with a solid handle will do, though a stencil-cutting knife is about the best. You can get along very well with an ordinary kitchen vegetable knife.

If you have a set of wood-carving tools at your disposal, you will find almost all of them useful, especially a U-gouge about ¼ in. wide and a small V-gouge. Flat chisels of two or three sizes are also convenient.

All cutting tools should be kept as sharp as possible, for the linoleum is soft stuff and will sometimes push ahead of the tool rather than stand up to it. The result may be a sudden slip and a badly scarred piece of work.

Bits of sawdust in the body of the linoleum are occasionally troublesome, one must be on the watch for them, as their sudden and unexpected yielding is another cause of slipping.

A carpenter's bench is about the best to work on; failing that, a table which can stand a certain amount of rough usage.

Carved and painted panels of linoleum can be inserted in cabinet doors and applied in various ways to many different types of furniture.

Your design may be drawn directly on the linoleum, but you undoubtedly will prefer to work it out on paper first and then transfer it with carbon paper. This is almost essential if you want duplicate designs.

If the linoleum is light in color, the carbon lines will show up well, but a dark linoleum may require a different process. I have found that a good method is to cover the back of the paper with a coat of white wax crayon and then offset the white wax to the linoleum with a stylus.

After the design has been drawn on the linoleum a knife cut is made about half way through the material, the cut being vertical

Whichever way you do it, you will probably find it desirable to go over the transferred design with India ink to prevent obliteration of the lines while you are working.

In drawing your design, it is well to bear in mind that most work of this kind is improved by having a border round it, and care should be taken to allow for this from the beginning.

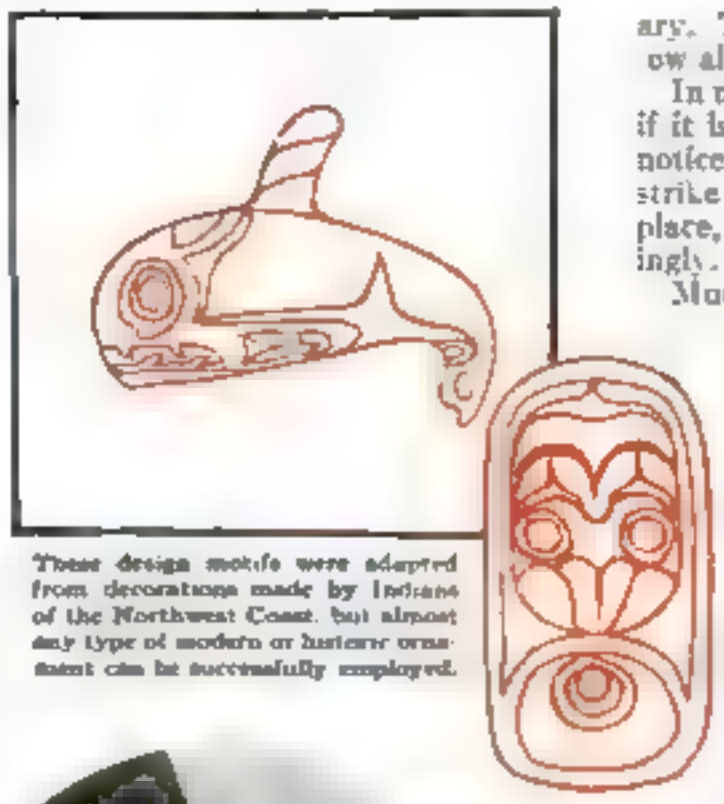
The work illustrated consists essentially of two contrasted surfaces, the original linoleum surface and a background about ⅛ in. below, which is reached by excavating certain areas. Other types of carving may be employed also, just as in the conventional wood carving.

If you intend to follow the type of designs shown in the illustrations, use a knife to cut the outline of the part you wish to work on first. The cut should not be deep enough to go more than half way through the material, and care should be taken to keep the knife vertical so that the excavated area may have straight walls. It is well to rest the forefinger of the left hand on the back of the knife blade near the tip to guide and steady it.

THEN take a U gouge, if you have one, and run parallel grooves all across the part which is to be cut away. The ridges left between the grooves may be cut down with a flat chisel, and the required depth will soon be reached. All the work may be done with the chisel if necessary.

Very often tool marks can be made to play a valuable part in obtaining the finished effect Short or long, deep or shallow, narrow or broad, parallel or irregular, each type of working gives a different surface. A judicious use of this idea adds much to the richness of the work and the possibilities of the craft

Some notion of the general effect may be gained from an examination of the background of the upper illustration on page 81, which is a cut made directly from a sample carving instead of from a photograph as is custom



These design motifs were adapted from decorations made by Indians of the Northwest Coast, but almost any type of modern or historic ornament can be successfully employed.

The background spaces are cut down by scoring a number of lines across them with a gouge and then removing the ridges with a chisel.

Cupboard doors which were shown at a handicraft festival in Ottawa by Mr Leechman. The door panels were made by the method described.

Additional suggestions for Indian designs. Mr. Leechman, who prepared these drawings, is a member of the staff of the National Museum of Canada, Division of Anthropology

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ary. The cupboard doors illustrated below also show the method

In making use of this scheme, it is well if it is to be used in your own home, to notice from what angle the light will strike the finished work when it is in place, and to plan your tooling accordingly.

Much, too, can be done with shallow grooves cut with a small V gouge and lines can be emphasized or merely indicated by varying the depth of the cut. Beware of cutting too deeply, and be especially careful when the end of your cut is close to the edge of the part you are working on. Sometimes a piece taken out by mistake can be glued back into place, but that is an expedient for emergencies only and is not recommended as standard practice.

When the actual carving is finished and all loose particles have been removed, the work is ready for painting. Oil colors in tubes are what I prefer, and I use turpentine as a medium rather than linseed oil, as it gives a smoother finish

Do not try to paint as if you were working on a canvas; keep rather to broad, flat poster effects, and avoid delicate shading and brushwork. Be careful that your color scheme is harmonious in itself, and also with the surroundings of the finished job, if you know what they will be.

Let the paint dry thoroughly, applying two coats, should that appear necessary. Then, if you wish, give it a coat or two of good clear varnish.

In some cases you will find it desirable to strengthen the material by gluing it onto a sheet of plywood. This may be done with any good glue by coating both surfaces, letting them stand for a few minutes, and then applying them firmly and accurately to each other Let them remain overnight under a heavy weight

SHIP model makers can clear their benches and sharpen their tools in preparation for the November issue of POPULAR SCIENCE MONTHLY, which will contain the first of a noteworthy new series of articles by Capt. E. Armitage McCann. In response to many requests from readers, he has been working for months on a model of the *Bluenose*, famous racing fishing schooner. This is the model he will now describe and illustrate.

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Knocks That Tell of Motor Ills

Unusual Noises Are Symptoms of Trouble, Says Gus, But Don't Let Your Ears Spoil the Fun of Driving

By MARTIN BUNN

"THERE! Hear that? There it is again!" Bancroft exclaimed, as he singed the tip of his ear on the hot exhaust manifold in the attempt to listen more closely. "I tell you there's something wrong with that motor."

Gus Wilson listened intently for a few moments.

"Mr Bancroft," said the veteran auto mechanic, "there's nothing wrong. What you hear is the clicking of the valve tappets. I can set 'em tighter if you want me to, but I d advise against it. If the tappets are set too tight the valves may not seat when the motor is cold, and the valve seats and the faces of the valves get burned. I'll check 'em to make sure they are as tight as they ought to be."

After Bancroft was convinced that his motor was properly adjusted and had driven away, Gus turned to Joe Clark, his partner in the Model Garage. "It's all right for a man to be fussy about the condition of his car," he growled, "but that bird Bancroft makes me tired. He's always got his ear working overtime trying to hear knocks and things in the motor."

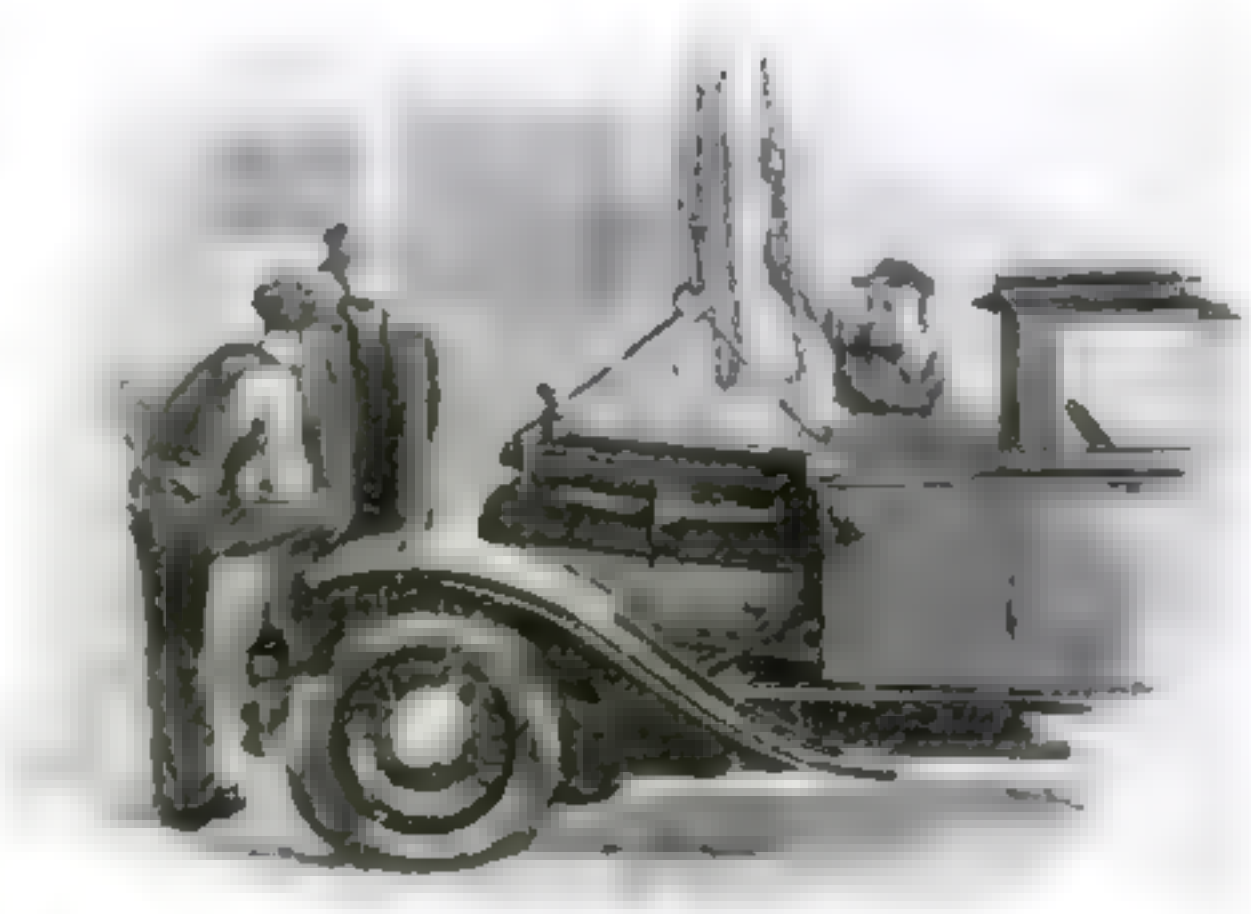
"They're not all that way," grinned Joe. "Fellow left a car here last night just after you'd gone. The windshield wiper was on the blink and he wanted it fixed. He spent ten minutes bragging about what a fine car it is. There it is over in the corner. Start the motor and see what you think of it."

Gus reached in and pushed the starter pedal with his hand and the engine started at once.

"Suffering cats!" he shouted, to make himself heard above the clattering and thumping of the motor. "I don't see that the owner of this car has anything to be proud of. Sounds terrible to me."

"IS THAT so!" snapped the sarcastic voice of the owner, who had arrived just in time to catch the end of Gus's remarks. "Trying to drum up trade are you? Maybe the car is a bit noisy, but I wouldn't hesitate to start for the coast in that bus any day."

"You could start easy enough, Mr Dobey," said Gus, noting the name of the owner on the repair ticket, "but it's kind of doubtful if you'd get there. Too many things in the motor in bad shape. Let's take it out on the road so I can hear what's wrong."



"If any of the things I say are loose turn out to be tight," announced Gus, as he began to hoist the noisy engine out of its frame with the portable crane, "I'll do the rest of the job at half price."

"Now," said Gus as they started down the road, "keep it running smoothly at about fifteen miles an hour till we get to the top of that hill."

"What's the sense of going so slow?" Mr. Dobey inquired.

"At fifteen miles the normal motor noises don't amount to much, and you stand some chance of hearing the queer ones."

They drove on for a short distance and as they started up the grade Gus said: "It's kind of hard to dope the knocks when there are so many different ones, but that light knock is either loose piston rings, a loose piston, or both. Those muffled knocks indicate that at least two of the connecting rod bearings are loose, and that thump like somebody pounding on a block of wood with a mallet is the main bearing. The other jumpy thumping noise means the motor is loose in the frame. Of course the sharp, metallic knock means thick carbon deposits on the cylinder head and the top of the piston. The rest of the clatter comes from the valve mechanism. You might as well turn back now."

"What are you trying to do, kid me?" sneered Dobey. "The motor couldn't be as bad as that. How do I know you're not just trying to get away with a fat bill for overhauling?"

"Say, mister," Gus smiled, "I've been in this business long enough to know what I'm talking about. You stick around while I yank the motor out of the frame, and if any of the things I say are loose turn out to be tight, I'll do the rest of the job at half price."

"FAIR enough," Dobey admitted as they rolled into the Model Garage. He watched closely as Gus got the portable crane ready to hoist out the motor.

"Of course if only piston rings and a loose connecting rod needed to be replaced," said Gus, "there'd be no sense in going to all this trouble. We fix things like that by dropping the oil pan. But your main bearings are in bad shape, and I'd rather get the engine out where I can do the job right.

"Now before I start," Gus continued, "take a look at the bolts holding the motor in place. This one here is so loose you can turn it with your fingers. If you'd kept on running the motor in that condition, the pounding would have busted the motor support and then you'd

Ask Gus—He Knows

HIGH compression cylinder heads are all right if you want maximum speed and economy, but there's no denying that they make a rougher-running motor. Also, if you get a tank full of poor gas, a high compression motor will knock like a boiler factory.

If you have a car with a high compression cylinder head fitted to the motor and you don't care about the extra economy and flashy performance to put up with the disadvantages, it's easy to reduce the compression without buying another cylinder head. Next time the carbon is removed, have the service man put in two cylinder head gaskets instead of one. If that doesn't do the trick, try putting in three gaskets.

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Fords Porcelain Works, at Perth Amboy, N. J., operate kilns for firing porcelain fixtures of all varieties. The kilns reach a temperature of 2390 degrees Fahrenheit at the end of each firing. Insulating these kilns with Johns-Manville Sil-O-Cel has resulted in saving fuel oil representing a return of 72% each year on the cost of the insulation. In other words, this means that the cost of J-M Sil-O-Cel Insulation was paid for in 16¾ months. Also, the working space on the floors above the kilns was made available for a work room through the reduction of uncomfortable temperatures which had existed before insulation was applied — another direct saving.

All kilns wherever used can be insulated to effect large annual savings. Nor is the effectiveness of Johns-Manville insulating materials confined to the insulation of kilns. For every industrial process which makes use of heat, there is a suitable Johns-Manville Insulation.

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Let a Johns-Manville Insulation Engineer help you to save money by saving lost heat energy. A J-M expert will be glad to call without obligation. Write us a note or use the convenient coupon. In many cases we can show you savings even greater than those attained at Fords Porcelain Works.

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Summary of Net Annual Savings Due to J-M Insulation at Fords Porcelain Works

Total annual fuel oil savings per kiln	$365.00
Annual charges for the insulation	64.89
Net annual savings per kiln	298.11
Investment in the insulation	412.70
Net annual return on the investment —72%	
Investment is entirely paid for in about 16¾ months	
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have been up against a man's size repair bill."

"No doubt about the looseness there," Dobey admitted glumly after he had turned one of the bolts with his fingers. "I thought this talk about telling what's wrong with a motor by the sound was bunk, but I guess there's something to it after all."

"Like most things," Gus smiled "there's some truth mixed with the bunk Any smart Aleck who tells you he can spot any trouble in a motor right away just by listening to it is shooting hot air But a smart mechanic should be able to locate anything that's really loose, by the sound.

"Then there's ways of running down particular troubles. For instance, if you hear a knock that you think is a loose connecting rod bearing, and you can hear it with the motor idling, short-circuit the spark plugs one at a time. When you cut out the explosions in the cylinder with the loose connecting rod, the noise will stop or get weaker. If shorting the plugs doesn't affect the noise, you can be sure something besides loose connecting rods is setting up most of the clatter."

Loose connecting rod and main bearings cause most of the noise in motors, I suppose," suggested Dobey.

"Some people have that idea," Gus replied. "and the minute they hear a clank in the motor they suspect the bearings. Most times the noise comes from the valve-operating mechanism. There may be too much play in the tappets, the push rod guides may be worn, or the cam shaft bearings may be loose. Of course, no one wants to ride in a car that rattles and clanks like an old junk wagon, but noises from the valve mechanism are not so important as loose connecting rod or main bearings. When bearings get so loose that you can hear them they ought to be fixed right away. If they're not, pounding may crystallize the shaft and break it, and that *is* serious. The valve mechanism can be loose enough to make a lot of clatter without causing any particular damage. Timing gears can rattle mighty loud without breaking."

"Gee!" exclaimed Dobey, "I don't think I'll get any fun out of driving if I have to keep listening for noises all the time

"Neither would I," Gus agreed. "What you want to do is to get your ears accustomed to the sound of the motor when it's running right. Don't keep *trying* to hear funny noises—just let your ears tell you of noises that really are loud enough so there's no doubt about you hearing them

You'll notice, too, that the motor always seems to sound quiet when you're in traffic, but after you've driven for an hour or two at a steady pace on a trip your ears begin to pick out and magnify little sounds that don't mean anything Then, when you start out again the next day, you wonder where all the noises went to that you heard near the end of your trip the day before."

"I get you," nodded Dobey. "Your idea is to mix a little common sense with the listening."

"Common sense is handy—even in a car," grunted Gus. "But we'd go out of business if it got too common!"

Mystifying *with a* Magical Ink Bottle

By GEORGE S. GREENE

YOU have probably noticed the sensation caused at social gatherings by someone perhaps disguised as a gypsy who was able to "tell fortunes." Here is a trick which will go the professed amateur palmist one better and with which you can excite double the amount of curiosity It can be guaranteed as a sure cure for "pepless" parties.

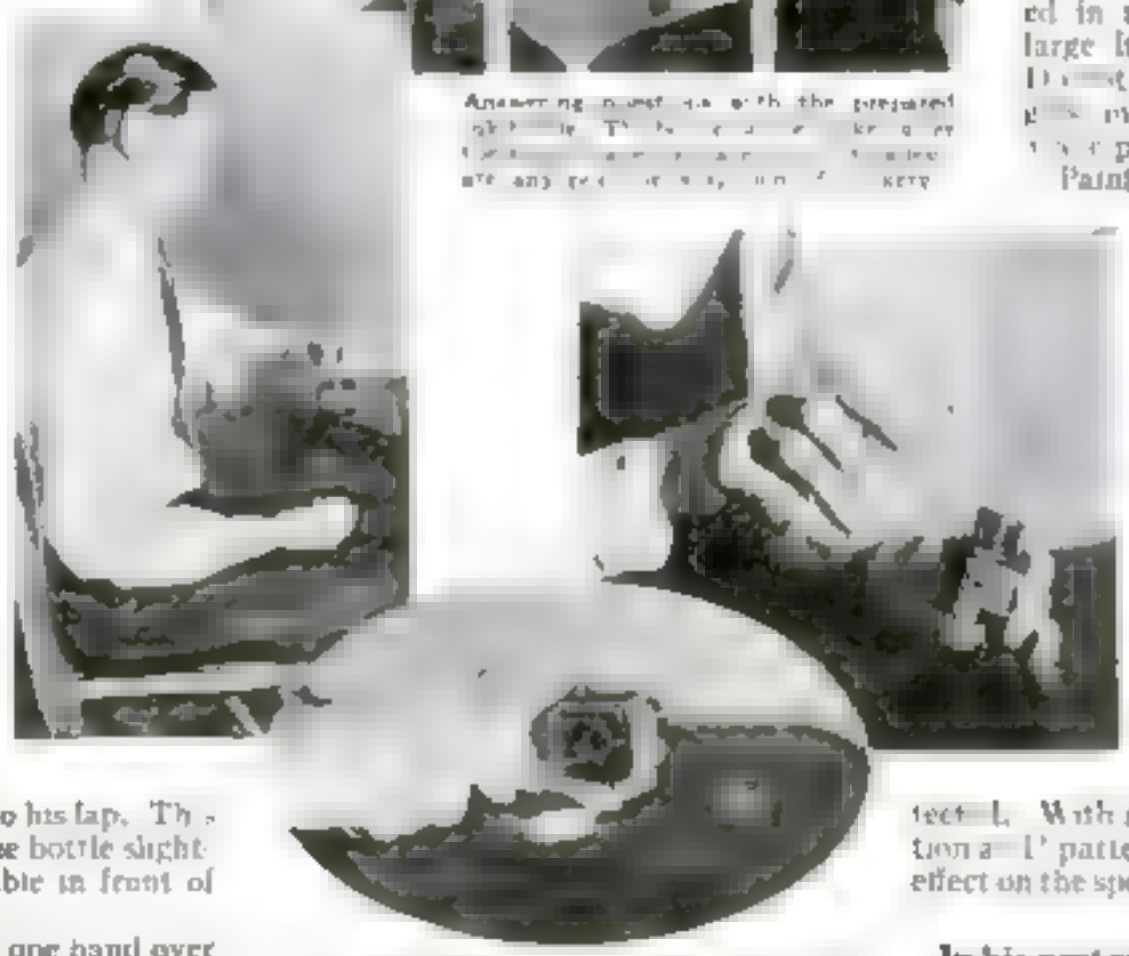
The performer sits facing the spectator across a parlor table in a side room. On the table is an ink bottle. The spectator is requested to write a question secretly and to fold it and place it in the ink bottle After several moments the performer, in a mysterious manner, answers the question and gives the information desired

The secret lies in the preparation of the innocent-appearing ink bottle. It has a hole drilled in the center of the bottom, and fitting loosely in the hole is a brass tube that extends up to the bottle mouth. The question goes into the brass tube. Then, as the performer moves the bottle about the table as if "making a spell," he allows the tube to drop into his lap. This he does easily by pulling the bottle slightly over the edge of the table in front of him as shown above.

He "concentrates" with one hand over his eyes, meanwhile looking downward under this cover and reading the question which his other hand has removed from the tube and opened.

At the conclusion, or even before the question is answered, the question slip may be restored to the tube and the latter returned to the bottle, to be fished out afterwards and handed to the amazed spectator.

Answering a question with the prepared [illegible]



How the question drops past the table edge into the performer's hand and two steps in preparing the hole in the bottle through which the tube slides.

THE illustrations show how to trick the bottle. The hole is [illegible] with the sharpened point of a file. When you have succeeded in making a small hole, enlarge it with larger round files. Don't hurry, for best results the glass must be filed away slowly in fine powder.

Paint the inside of the bottle black. When the paint is dry fill all but the space for the tube with plaster This is done by inserting a waxed paper tube through the bottom hole and pouring the plaster around it at the wider mouth of the bottle, as shown in the illustration immediately at the left. When the plaster is hard, there is a smooth socket or guide for the brass tube.

The tricked bottle, if presented with reasonable care, is never detected. With sufficient adroit mystification and "patter" from the performer, the effect on the spectator is astonishing.

In his next article, Mr. Greene will describe several effective pocket tricks which can be shown anywhere.

Ingenious Kinks for Motorists

Protecting the Face When Under Car—An Emergency Flange Repair—Other Useful Ideas

Each month POPULAR SCIENCE MONTHLY awards a prize of $10, in addition to regular space rates, for the best idea sent in for motorists. This month's prize goes to Merrill Devore, of Cowiche, Wash., for his suggestion of a face protector useful in automobile repair work, shown in Figure 1. Other contributions published on this page are paid for at the usual space rates.

PROTECTION of the eyes and face from dirt and grease while working beneath an automobile is afforded by the ingenious homemade mask shown in Figure 1. Take a piece of celluloid, such as is used for the windows in the curtains of open cars, and with a couple of pieces of string tie it in semi-circular form about the face. It will afford complete protection for the eyes from bits of caked dirt that are sure to be loosened by hammer or screw driver.

Emergency Flange Repair

FIGURE 2 shows an emergency method of repairing a broken carburetor flange which may prove serviceable on a trip. It will do the trick until a service station or garage can be reached, and the broken flange replaced with a new one.

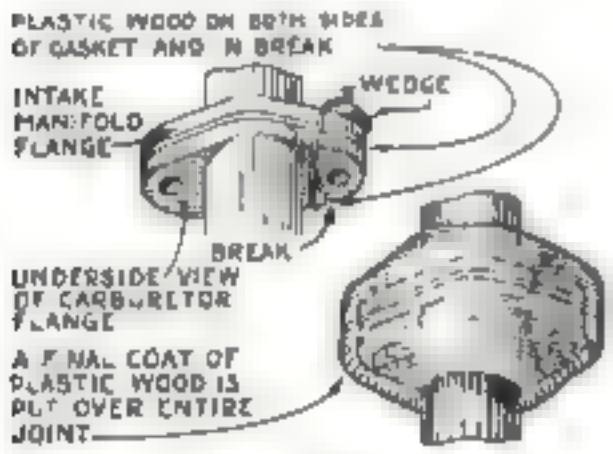


Fig. 2. An emergency repair of a broken carburetor flange, using composition wood to patch.

As shown in the illustration, the broken parts are temporarily wired together and a coating of a wood paste placed over the entire flange. After this has dried, two or three more coats of the wood paste are spread over the joint until it is in the form shown in the illustration. The repair will be surprisingly strong and also will be air tight. Do not attempt to put a single, thick layer of the composition wood over the joint, as it will not dry as well as if applied in successive layers.

In Inner Tube Saves Shoes

IN MANY types of cars grease has a tendency to work out, to some extent, around the bottom of the gearshift lever. The shoes of a driver are likely to come in contact with this grease and be stained. To eliminate the trouble, cut a short section from an old inner tube and slip it over the gearshift lever to the bottom, as in Figure 3. This idea will prove valuable particularly in protecting light colored shoes. If the piece fits too loosely, it can be held in place by a thin band of rubber cut from the same tube and doubled.

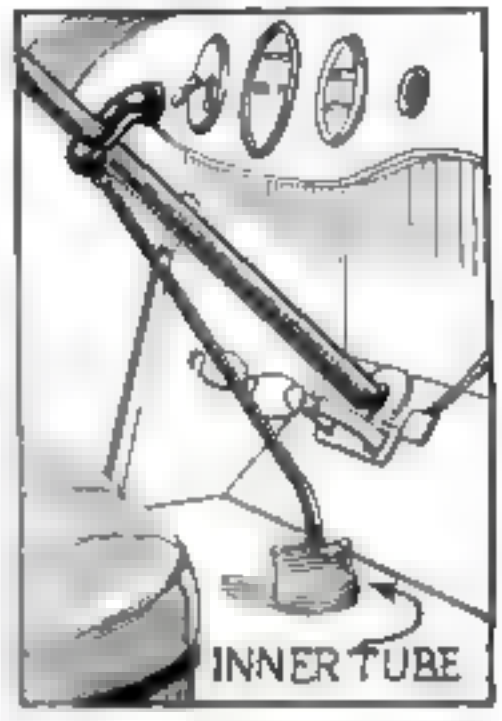


Fig. 3. A piece of inner tube around gear shift base protects the shoes.

Spark Plug Hole Cleaner

AFTER the cylinder head has been scraped free from carbon, it is desirable to remove the carbon from the lower threads in each spark plug hole. A simple way to do this is to grind or file grooves across the threads of an old spark plug, as shown in Figure 4. Remove the gasket and screw the filed plug into the hole. It will seat slightly deeper than the standard plug and will remove carbon from the thread groove. A still better method, if a lathe is available, is to turn down the body of the spark plug, just above the threaded portion, to a diameter slightly smaller than the bottom of the groove. Then slot the threaded portion with a hack saw, so that it can be screwed clear down to remove all the carbon from the bottom of the threads.

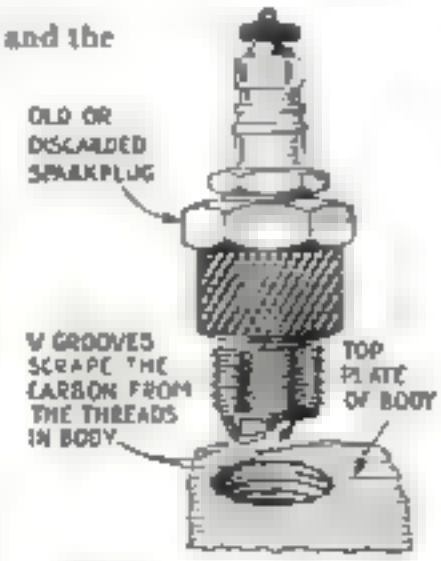


Fig. 4. Using an old spark plug to remove carbon from threads of spark plug hole.

Simple Garage Door Check

FIGURE 5 shows a novel and very simple door check that will prevent the door of a garage from blowing closed. A block of wood is screwed to the door and another flat piece of board is hinged to it by means of an ordinary strap hinge. A spring is hooked between two nails, one in the fixed portion and one in the movable portion. When the movable portion is turned up the spring holds it up; when turned down the spring tends to hold it against the ground.

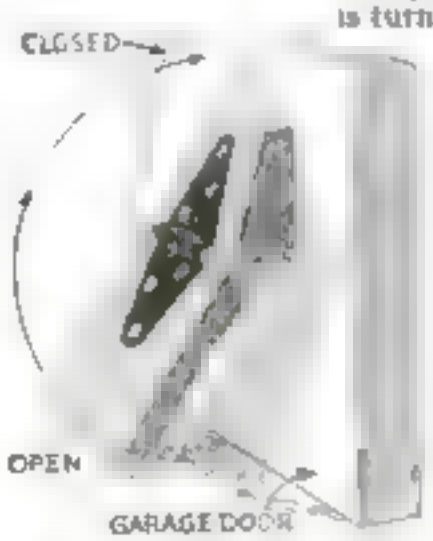


Fig. 5. A simple door check made with hinged blocks of wood and a small spring.

Front Tire Wear

FRONT tires on cars fitted with four-wheel brakes may wear more rapidly than the rear tires if the front brakes are set too tight. This trouble can be eliminated by making sure that the front brakes do no more than their fair share of the work of stopping the car. In most cases, however, where the front tires show excessive wear, the trouble is caused by incorrect wheel alignment.

NEWS for the owners of

Buick
Hupmobile
Auburn 8
Graham-Paige
Nash

FIND YOUR CAR

Here is a partial Mobiloil Chart covering most of the leading passenger cars made in the United States. Check up now. Find the correct grade of Mobiloil for your car. The recommendations below were made after practical and scientific tests of the New Mobiloil in your type of engine. Make this Mobiloil Chart your guide.

NAMES OF PASSENGER CARS	1929 Engine		1928 Engine		1927 Engine		1926 Engine	
	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer
Auburn, 6-cyl. 8-cyl.	BB	Arc	BB	Arc	BB	Arc	A	A
" other models	A	Arc	A	Arc	A	Arc	A	A
Buick	BB	Arc	BB	Arc	BB	Arc	A	Arc
Cadillac	BB	Arc	BB	Arc	BB	Arc	BB	Arc
Chandler Special Six			A	Arc	A	A		
" other models	A	Arc	A	Arc	A	Arc	A	Arc
Chevrolet	A	Arc	A	Arc	A	A	A	Arc
Chrysler 6-cyl. Imperial 80 and Imperial			A	A	A	Arc	A	Arc
" other models	BB	Arc	BB	Arc	A	A	A	A
Dodge Brothers	A	A	A	Arc	A	A	A	A
Durant	A	Arc	A	A	A	Arc	A	Arc
Elcar 8-cyl.	BB	Arc	BB	Arc	BB	Arc	A	Arc
" other models	A	Arc	A	Arc	A	Arc	A	A
Essex	A	Arc	A	Arc	A	Arc		
Erskine	A	Arc	A	Arc	A	Arc	A	Arc
Ford, Model A	A	Arc	A	Arc				
" Model T					F	F	F	F
Franklin	BB	Arc	BB	Arc	BB	BB	BB	BB
Gardner, 8-cyl.	BB	Arc	BB	Arc	BB	Arc	A	Arc
" other models							A	A
Hudson	A	Arc	A	Arc	A	Arc	A	Arc
Hupmobile	BB	Arc	BB	Arc	A	Arc	A	Arc
La Salle	BB	Arc	BB	Arc	BB	Arc		
Lincoln	BB	Arc	BB	Arc	BB	Arc	BB	Arc
Marmon, 8-cyl.	A	Arc	A	Arc	A	Arc		
" other models			BB	A	A	A	A	A
Moon	A	Arc	A	Arc	A	Arc	A	Arc
Nash, Adv. & Sp. 6	BB	Arc	BB	Arc	BB	Arc	A	Arc
" other models	A	Arc	A	Arc	A	Arc	A	Arc
Oakland	A	Arc	A	Arc	A	Arc	A	Arc
Oldsmobile	A	Arc	A	Arc	A	Arc	A	Arc
Packard	A	Arc	A	Arc	A	Arc	A	Arc
Peerless, 77, 90, 91	BB	A	BB	A	BB	A	BB	A
" other models	A	Arc	A	Arc	A	Arc	A	Arc
Pontiac	A	Arc	A	Arc	A	Arc	A	Arc
Reo	A	Arc	A	Arc	A	Arc	A	Arc
Studebaker	A	Arc	A	Arc	A	Arc	A	Arc
Whippet	A	Arc	A	Arc	A	Arc	A	Arc
Willys-Knight, 6-cyl.							B	Arc
" 8-cyl.	BB	Arc	BB	Arc	BB	Arc	BB	Arc

We have proved in thousands of miles of test driving on the Atlantic City Speedway, and in hundreds of laboratory tests, that the New Mobiloil "BB" gives the greatest summer protection and adds the most power to Buick (1929, 1928, 1927 models), Nash (Advanced and Special Six 1929, 1928, 1927 models), Hupmobile (All 1929 and 1928 models), Graham-Paige (All 1929 and 1928 models), Auburn 8's (1929, 1928, 1927 models). If you own one of these cars remember to *ask for Mobiloil "BB"*. The price is 35¢ a quart (price slightly higher in Rocky Mountain and Pacific Coast States), and there is a Mobiloil dealer always nearby.

Mobiloil "BB" is also recommended for other makes of cars. See chart at the right. If your car is not listed in it, consult any Mobiloil dealer.

No matter which make of car you drive, the way to be sure of correct lubrication for your automobile engine is to buy oil according to the Mobiloil Chart.

Regular draining and refilling with the New Mobiloil will keep the first-year feel in your engine for at least 30,000 miles.

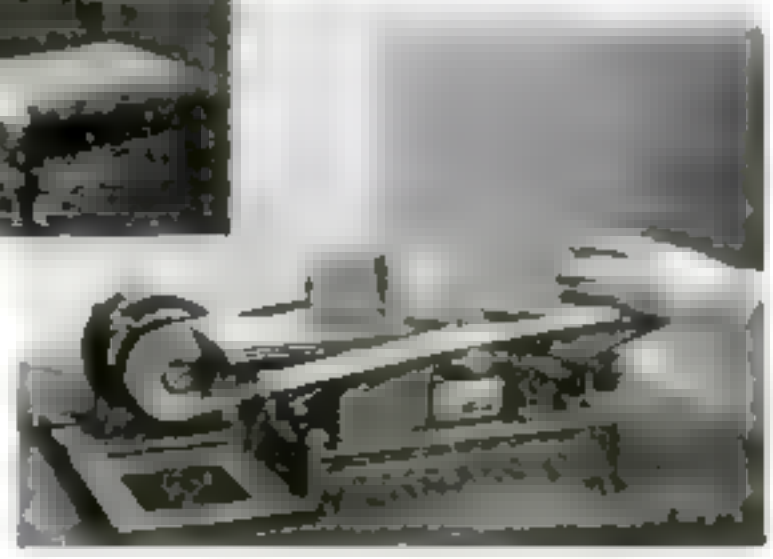
VACUUM OIL COMPANY
Makers of high-quality lubricants for all types of machinery

the New Gargoyle Mobiloil "BB"

Operating Small Shop Machinery

By WILLIAM W. KLENKE

Cherry Maryland end table—illustrated by Mr. Klenke who is a manual training teacher of national reputation and the author of *Art and Education in Wood-Turning*



Planing the edges of the table top on a bench jointer. It is [illegible] very firmly against the fence.

Sawing one of the [illegible] on the jig saw at left and turning a leg [illegible] Note the guard [illegible] of the handle holding the skew turning tool

IN LEARNING to use small woodworking machinery of a [illegible] you will find this Maryland end table a particularly instructive and desirable piece of furniture to build. Because of its delicate proportions and graceful lines, it is a little gem, at the same time it is simple in construction, and the materials are inexpensive.

Mexican mahogany is one of the best materials for this table, unless you intend to finish it with colored brushing lacquer, perhaps in some brilliant tone to make the piece individual and outstanding, in which case birch or maple is suitable. Because of the delicate proportions, a hard, strong wood must be used.

With this project, as in the two preceding articles of this series on making the most of small machines, we shall do the work almost entirely by machine. Obviously, the same general methods can be used in constructing many kinds of tables and, indeed, in much furniture building. If you own any machines or intend to equip your home workshop with them, you will find that a mastery of the few simple principles involved will make possible the production of cabinet-work of professional quality.

STEP No. 1—Getting Out Stock. Using the planer and circular saw, get out all the stock in the following manner (the various pieces of wood used to make a piece of furniture are generally known as stock).

On the planer, dress one surface smooth and true, mark this with an X to indicate the working face. Hold this face against the fence of the planer and plane one edge at right angles to the working face. Mark this edge also with an X to identify it as the working edge.

Hold the working edge against the fence of the circular saw and rip the stock to the correct width, allowing ⅛ in. for planing. In like manner obtain the thickness. Return to the planer and dress all sawed surfaces smooth and true. Follow this method for preparing all the pieces. At this point it is advisable to cut out cardboard patterns of all curved parts.

Step No. 2—Turned Legs. The stock for the legs should be at least ½ in. longer than the finished measurement, to allow for turning the bottom end without striking the point of the dead center.

Draw diagonal lines on both ends of the stock to locate the centers. Bore small holes at these points to receive the center pins. Square lines around the stock to locate the portions that are to remain square.

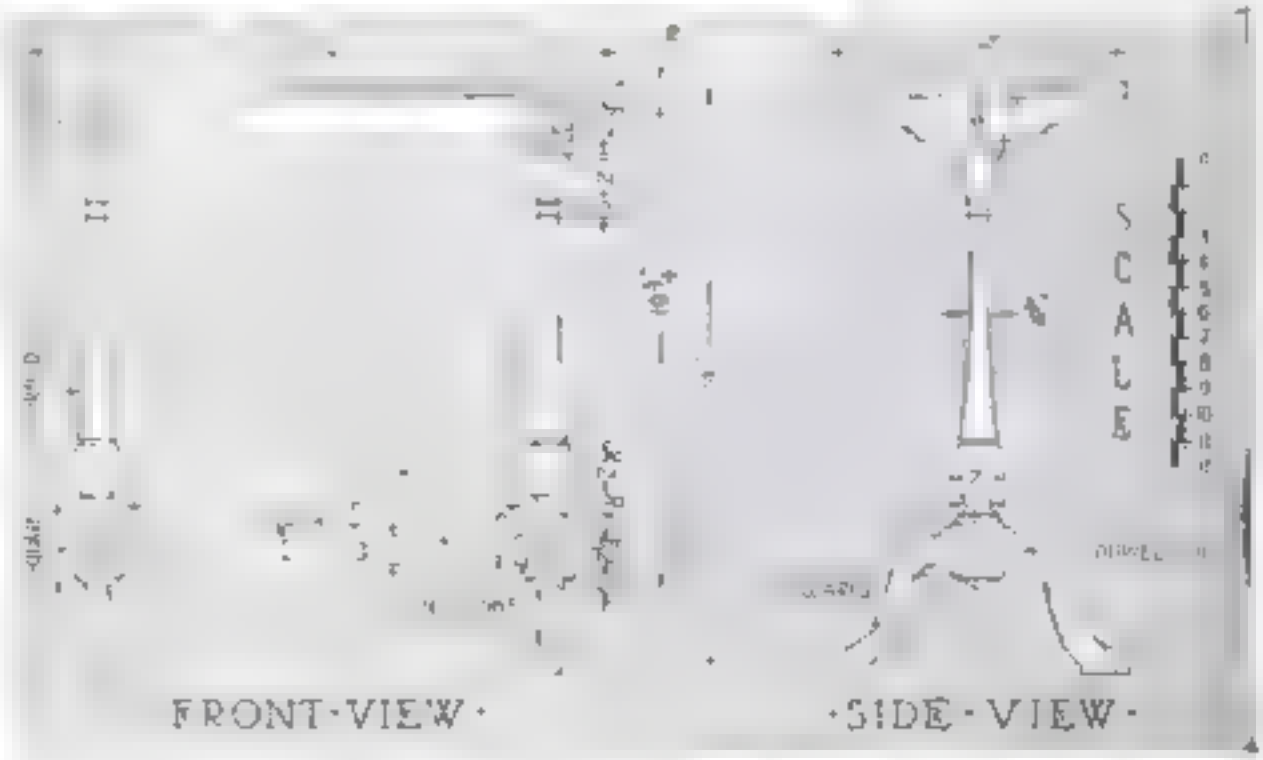
Rough the stock with a gouge and turn to the design. Sandpaper thoroughly while in the lathe. If you lack experience with a lathe it will be worth your while to look up the series of articles recently published in POPULAR SCIENCE MONTHLY on wood turning, or to obtain a good book on turning.

Step No. 3—Curved Feet. Cut out the curved outline on the jig saw and smooth the edges on the drum sander. Use the disk sander for the flat bottom and top edges as in step No. 5.

Step No. 4—Top Brace. On the jig saw cut out the outlines of the braces, on the drum sander, true and smooth the outline.

Step No. 5—Joints. True the top and bottom flat edges of the curved feet on the disk sander. Carefully locate all the dowel holes. Place the chuck and dowel bit in the lathe and bore all the holes the correct depth.

Step No. 6—Sandpapering. Before assembling the



A table slightly simpler in design than the one shown in the upper photograph. The edges of the top can be left unornamented if no suitable molding plane or hand beading tool is available for the work.

C & L 32

This is one of the most popular blow-torches we have ever made. It is more expensive than the 158 because it is made for much harder use. It is designed for the man who uses a blow-torch in his daily business and demands not only excellent performance but rugged ability to stand rough handling. 32 contains the most advanced patented C & L blow-torch improvements. It also has a red handle with the gold stripe. Sure sign of satisfaction

ARE YOU PARTICULAR ABOUT YOUR TOOLS?

"You bet your life I am," you say. "When I buy a tool it's got to be right and *it's got to stay right.*"

When you buy a Clayton & Lambert torch you're putting a worth-while tool on your workbench. The most exacting blow-torch uses are considered in the manufacture of Clayton & Lamberts. Lasting materials—the strongest available, selected for long, efficient use. Many of the features of design are exclusive and patented Clayton & Lambert improvements—the result of 40 years' experiment and invention. And Clayton & Lambert torches are made by precision workmen. Men who think of tools and look at tools in the same light as you.

For instance—the vaporizing chamber has an exclusive vein system for quicker, hotter heat. That makes the torch function better and saves money on your fuel bills. All fittings are built into the tank by a patented method that prevents their falling in or coming out. There's *absolutely no danger* of an explosion with a Clayton & Lambert torch. Even the most delicate part—the gas orifice—is fool-proof. In the No. 158 the orifice has a guard. Slightly higher priced, No. 32 has a patented design so that you'll never ruin the torch by a careless twist of your wrist. And as you close the valve you automatically clean the orifice.

C & L 158

This blow-torch is especially made and priced for the man who likes to do odd jobs around the house or to tinker with mechanical things. It will last a lifetime if it is not abused. The usual retail price is about five dollars. Most hardware, electrical and automobile accessory stores have it or can get it for you quickly. Look for the red handle with the gold stripe.

Things of that sort have made Clayton & Lamberts the largest selling torches in the world. There's satisfaction and pleasure in working with such a fine, capable tool.

You can buy Clayton & Lambert torches at hardware, electrical and automobile accessory stores. Look for the handle—it's red with a gold stripe. But to be sure—look for the trade-mark, too. It pays you to be certain that you're getting a Clayton & Lambert.

CLAYTON & LAMBERT

MANUFACTURING COMPANY

Detroit, Mich.

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 4.

The drum sander is used for smoothing concave surfaces. The work can be held above or below the drum as necessary

MOTORIZED home workshops, once a rarity, are now becoming common. This is the reason why the hobby of making things is gaining so markedly in popularity. With the aid of small, reasonably priced, highly efficient motor-driven machines, even the beginner is able to accomplish wonders in woodwork. And he is released from the drudgery of sawing and planing by hand.

This article is the third of a series in which Mr. Klenke, through the courtesy of various manufacturers, demonstrates the use of many new home workshop woodworking machines of both combination and individual varieties.

table, thoroughly sandpaper all parts with No. 1, followed by No. ½, and 0 paper

Step No. 7—Assembly. Make a trial fitting between clamps without glue. First, glue the curved feet to the legs; then assemble the entire project using plenty of first class liquid glue or hide flake glue of good quality. The tops of the legs are held together by gluing a strip on each side of the leg Fasten the top to the braces with screws

The flat edges of the feet at both top and bottom are speedily trued to an accurate fit on the sanding disk

Step No. 8—Cleaning Up. Remove all excess glue with a sharp chisel, working across the grain where possible. Thoroughly sandpaper all parts with No. ½, 0, and 00 paper, always rubbing with the grain where possible, and rounding the corners slightly.

Step No. 9—Finishing. If a lacquer finish is to be used, first apply two coats of white shellac, rubbing each coat when dry with 00 sandpaper. Apply the lacquer according to directions on the can.

If you have used mahogany or walnut or a wood which is to imitate them, brush on water stain or a prepared wood stain or dye of the desired color, and after it is thoroughly dry apply a very thin coat of shellac. Water stain has a tendency to raise the grain, and the shellac will stiffen these fibers and make them brittle. Sandpapering lightly with No. 00 or finer paper will cut them down clean and smooth.

Apply two coats of good quality paste wood filler (unless you have used some close-grained wood) according to directions on the can. Allow at least two full days—a longer time is even more desirable—for the filler to harden. Then brush on three coats of white shellac, rubbing each coat when dry with No. 00 or finer sandpaper and the last coat with rubbing oil, light machine oil, or crude oil and fine pumice stone powder.

With a spraying outfit, you can spray on clear lacquer instead of using shellac.

Hints on Constructing Built-in Kitchen Cupboards

IN MODERN homes a kitchen cupboard extending from floor to ceiling often is built along one entire wall. If you live in a house without this convenience, you can construct a suitable cabinet yourself without much difficulty or great expense.

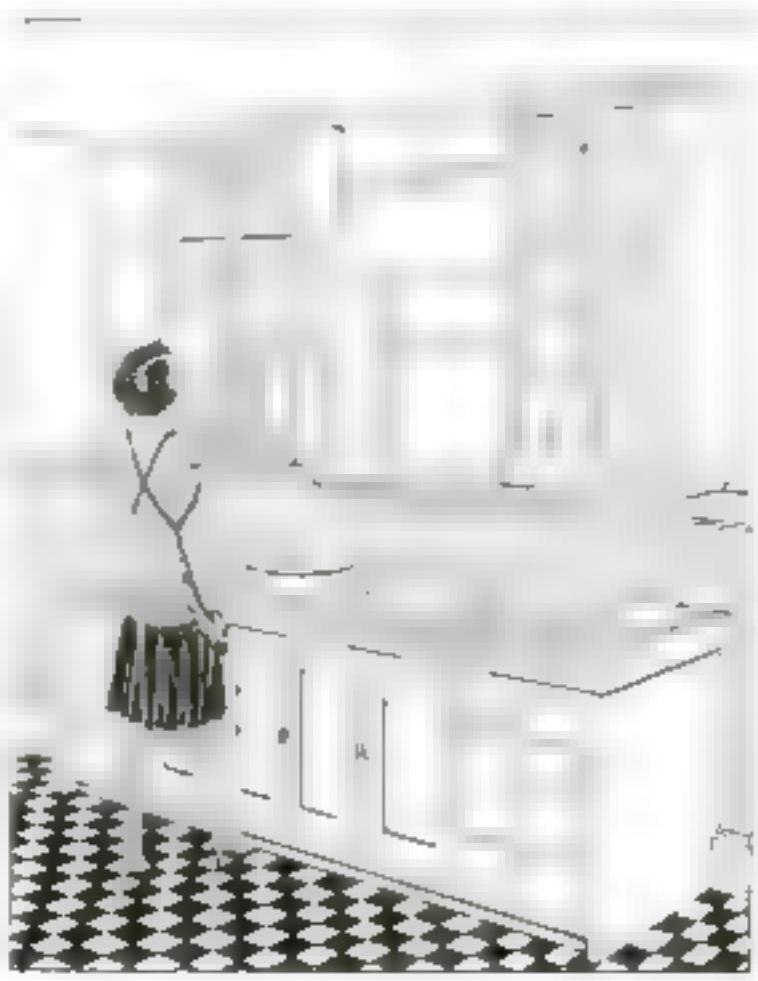
Measure exactly the space the cabinet is to occupy and make a drawing to aid you in both ordering the material and constructing the case

The lower part of the cabinet with the table or work shelf should be of a height to suit the housewife and in no case too low. In a large and elaborate cupboard I built for my own home, I made the lower part 2 ft. deep but left a toe space at the bottom as shown. This space extends 4 in. under the cabinet and is 2½ in. high.

The upper part can be relatively shallow and entirely separated from the lower part. I screwed ½-by 2-in. strips to the ceiling joists to serve for hanging the upper section and, of course, also fastened it to the wall.

The doors can be made with white pine frames and either plywood or pressed wood panels, the latter being thinner and cheaper, yet strong and durable

A good way to make the table top is to cleat together 1-by-12-in. white pine lumber—I used what is called "boxing"—and then cement floor linoleum on top. To lay the linoleum cement easily, make a trowel or paddle with a chisel edge from a thin board about 4 in. wide and notch the edge in saw-tooth fashion. Apply the cement and scrape the surface with the trowel, leaving only small ridges, not too close together. On this lay linoleum felt, heavy building felt, or even building paper



A homemade built-in cupboard with linoleum-covered working top. At the bottom is a recess to give toe space

Cut the linoleum to fit snugly and lay it on the felt, after applying the cement in the same way. Roll it down well and apply a small hardwood binding strip along the front edge of the top. At the back, along the wall and resting on top of the linoleum, a wooden strip 3 in. or more in width should be placed, to protect the plaster. Three coats of spar varnish will give the linoleum a durable surface

How attractive the cupboard looks depends mainly upon the good taste and care with which it is painted. A study of modern commercial kitchen cabinets will suggest color schemes. The door panels can be decorated, if desired, with transfer (decalcomania) designs.

A bread board can be made of ¾-in. plywood. If the plywood is not of the so-called waterproof variety, put together with casein glue, it should be liberally oiled with linseed oil.—CARL G. ERICH.

Good sandpaper is often thrown away before its usefulness is over Dust and gum, which fill in between the grits, can be removed by snapping the paper forcefully against the work or the top of the bench. Turning the paper around on the block also prolongs its life, because new edges of the gritty abrasive are presented to the work in each position. Ordinarily, for flat work, the paper is held around a block of wood, leather, cork, or rubber.

How to Choose and Use Files

Told by the World-Famous Makers of Disston Files

IN the Disston Saw Works, more than 35,000 dozen files are used every year. They are Disston Files, made of Disston Steel, cut and hardened with Disston skill. This daily use of Disston Files, by Disston saw-makers, guards the quality of *all* Disston Files.

For Disston Steel puts longer life—and faster, easier cutting—into files as well as saws. It is the world's great cutting steel, with toughness and temper unequalled. You will find a Disston File still cutting true, long after another file would be useless. Far longer service, mechanics say, and better service always. There is no substitute for genuine Disston Files.

Ask for Disston! Hand Saws, of course; but also Disston Files—every style, for every purpose.

Files for the Wood Worker

Disston Cabinet Files (fine teeth) for smoothing and finishing wood surfaces, casing cabinet doors and drawers, etc. Disston Wood Rasps (coarse teeth) for rough and fast cutting, enlarging holes, etc. Half round 8" Cabinet File, 65c. Flat 8" Wood Rasp, 50c.

Making a Disston saw

"The Saw Most Carpenters Use"

The two handiest saws for the home workshop are the 26-inch 8-point for cross-cutting, and the 26-inch 12-point for ripping. You will need these on almost every job. The popular "D-8" Lightweight is only $2.45. Many other styles and sizes to choose from.

Handiest of Pocket Levels

For truing up construction work, levelling shelves, etc., use a Disston Featherweight Pocket Level. It is the lightest and handiest level made. Length, 9" weight 4 oz. Aeroplane aluminum. Three proved glasses. $1.25.

HOLD file firmly against metal to be cut. Allowing file to slip dulls it quickly. Proper position is with left hand at point, thumb on top of file, with right hand holding handle. For fast cutting, rest ball of left hand on file. Cut on forward stroke, use full-length of file and cut with a straight, regular motion.

In draw-filing, or making a finish cut for flatness, take position shown at right.

Always keep file free from chips and filings, by using a file card and brush. Oil file before putting it away. Don't dull teeth by careless handling.

Single-cut files have one course of teeth diagonally across them, as in a taper saw file. Double-cut files have two courses of teeth, as illustrated below, with spacings of teeth differing as shown.

Bastard Second-cut Smooth

Bastard double-cut hand, flat and half-round files are widely used for fast cutting, with single-cut mill and taper files for a fine finish.

All good hardware merchants can supply Disston Files for every purpose, as well as Disston Saws and Tools.

Band Saws for Better Work

Disston "Thin Gauge" Narrow Band Saws are 2 to 3 gauges thinner. They run better on machines with wheels up to 60" diameter. Saw 3/8" long, 1/4" wide 25-gauge, brazed, $4.05. Other sizes in proportion.

For Cutting Dovetails, etc.

Wherever the finest possible point is needed, and for dovetailing, pattern making, etc., use a Disston No. 65 Dovetail Saw. Blade extra thin, with fine teeth. The 8" blade, 17 points to inch, is most popular. $1.60.

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Makers of "THE SAW MOST CARPENTERS USE"

For Your Power Saw Outfit

Disston Saws insure better work. Cut easier, stay sharp longer. Disston Circular Saws—cross-cut, rip or combination—are made to fit any make of machine. If your dealer cannot supply you, write to us for prices.

Every saw user will enjoy reading "The Disston Saw, Tool and File Book," an illustrated manual on the selection, care, and use of tools. It tells how to file and set saws, etc., and contains helpful information on the correct use of files. Use coupon, or write.

Henry Disston & Sons, Inc., Philadelphia, U. S. A.
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Please send me "The Disston Saw, Tool and File Book."

Name and Address_____

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

How a plain angle plate can be set at a slight angle by the use of a special adjustable plate.

How to Hold Angular Machine Shop Work

Setting Up Small Parts—Plates for Obtaining Variations Up to Twenty Degrees—Emergency Jobs

By HENRY SIMON

VERY small angles can be produced conveniently by a machinist or toolmaker with the aid of the adjustable blocks and plates of Figs. 1 and 2. In these devices, the angle is obtained by spreading the two "wings" by means of set screws, and holding the adjustment by corresponding lock screws.

As may be seen in Fig. 1 at *C*, the two wings should have a tendency to "punch" when free, the set screw therefore being under pressure even when the lock screws are loose. The angle is determined in the usual way, either with the help of a micrometer, as at *D*, or by measuring the opening of the slot with a feeler gage.

The blocks of Fig. 1, which are small affairs made from machine steel, are mainly intended for "blocking" underneath the work. By enlarging one wing, however, they may also be made into small angular holders, as suggested at *E*, where a toolmaker's vise clamp is shown set in the block.

Larger than the adjustable blocks are the angle plates illustrated in Fig. 2. The front edge of the slot is milled to a depth of about ¾ in. to allow measuring with a feeler gage.

It need hardly be said that a block or plate of this kind cannot be spread very much, and that it should not be used to obtain variations of over 1°, yet within this range it is not only very handy for obtaining small angles but is equally useful for making corrections. Quite often some large angle varies "by a hair" from the true, and even more frequently it is necessary to compensate for some fixed error in the machine. When an angle plate is used, in particular, the error in the plate is frequently added to the machine error to produce a noticeable discrepancy.

Such cases can be readily handled by incorporating the adjustable feature in a right-angle plate, as at *B*. With such a plate it is easy to obtain high accuracy without having to resort to makeshifts such as shimming.

An example is that at *D*, where the error in a miller table is corrected in this manner. With lighter work, nearly the same result can be achieved by clamping an ordinary angle plate to the plain adjustable-angle plate shown at *A* and truing up the whole in the machine, as at *C*, to eliminate the entire compound error.

T-slots, or tapped holes, or both, may be formed in the surfaces of these small-angle plates. The lock screws must not be too small and the set screws should be made with a round point and given a dish-shaped bearing on the opposite wing.

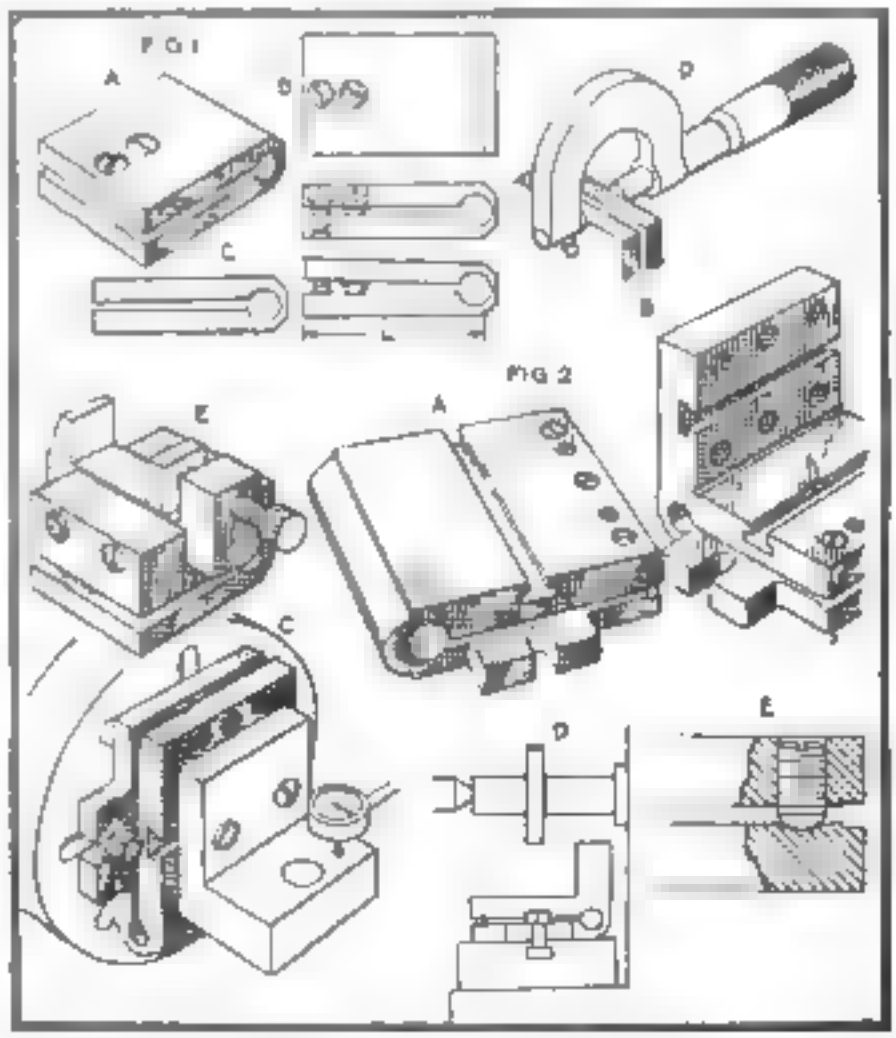
If the devices just illustrated are for obtaining very small angles, the adjustable-angle plate shown in Fig. 3 is intended for getting any angle from 0 to about 20° accurately and in a positive manner. It is designed for fairly large work or for mounting miller and drill vises. Though requiring some time to make, it will be found handy where work of this kind is regularly done.

The plate consists of a base *a*, to which a work-holding plate *b* is pivoted by a hinge pin *c* at one end. At the opposite end, the parts are held at the required angle by spreaders *d*. These spreaders are parallels of flat stock of different widths, they are a sliding fit in grooves in round seat bars *e*, which are a close turning fit in slots *f*. The two wings are locked together by four screws *g* working in revolving plugs *h*.

IN MAKING this plate, both surfaces of each wing should be machined before boring and reaming the hinge bearing. This operation completed, the corner *i* is backed off and about .010 in. ground from the top surface of the base. If the device is made with care, very accurate results can be obtained.

A useful addition for some purposes is that of graduated wedge type spreaders and a matching seat bar, as at *B* and *C*. Each wedge is slanted at a 6° angle and has a run of one sixth of its length, each of the six graduations on the large end, as shown at *C*, therefore corresponds to 10′ of arc. With this accessory, a set of, say, ten spreaders can be made to handle the complete range of angles from 0 to 10°, and adjustment can be instantly made without calculation to within about 5″ of arc. As shown in the illustration, the seat bars in this case should be formed with headed ends to prevent lateral shifting and resultant inaccuracy of the angle.

Now for some emergency measures—for, in spite of all that can be done, there will always be many cases where such measures are called for. How a block of wood, though ordinarily considered unfit, may be made to do for an angle plate, is illustrated at *A* in Fig. 4. A good, sound block of close-grained hardwood should be chosen. The end grain must be against the faceplate, and there should be as much end grain surface as possible. Any good millwright can get the two principal surfaces within, say, ⅛ in., and this may



Adjustable block for use under small angular work (Fig. 1), adjustable plates of plain and angle types, and their use (Fig. 2).

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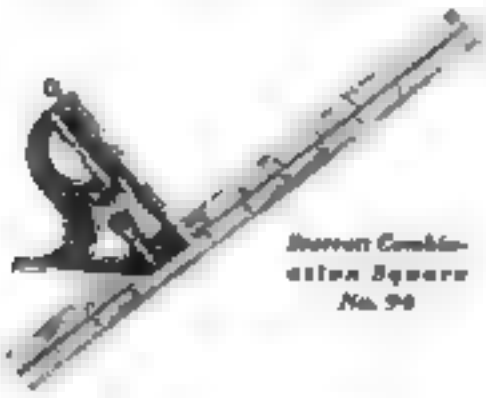

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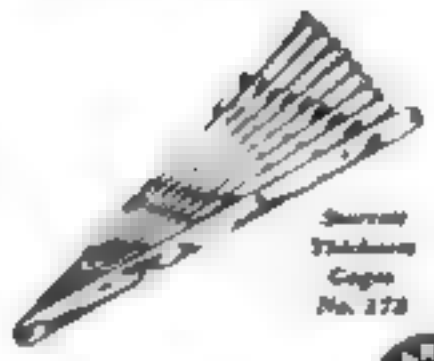

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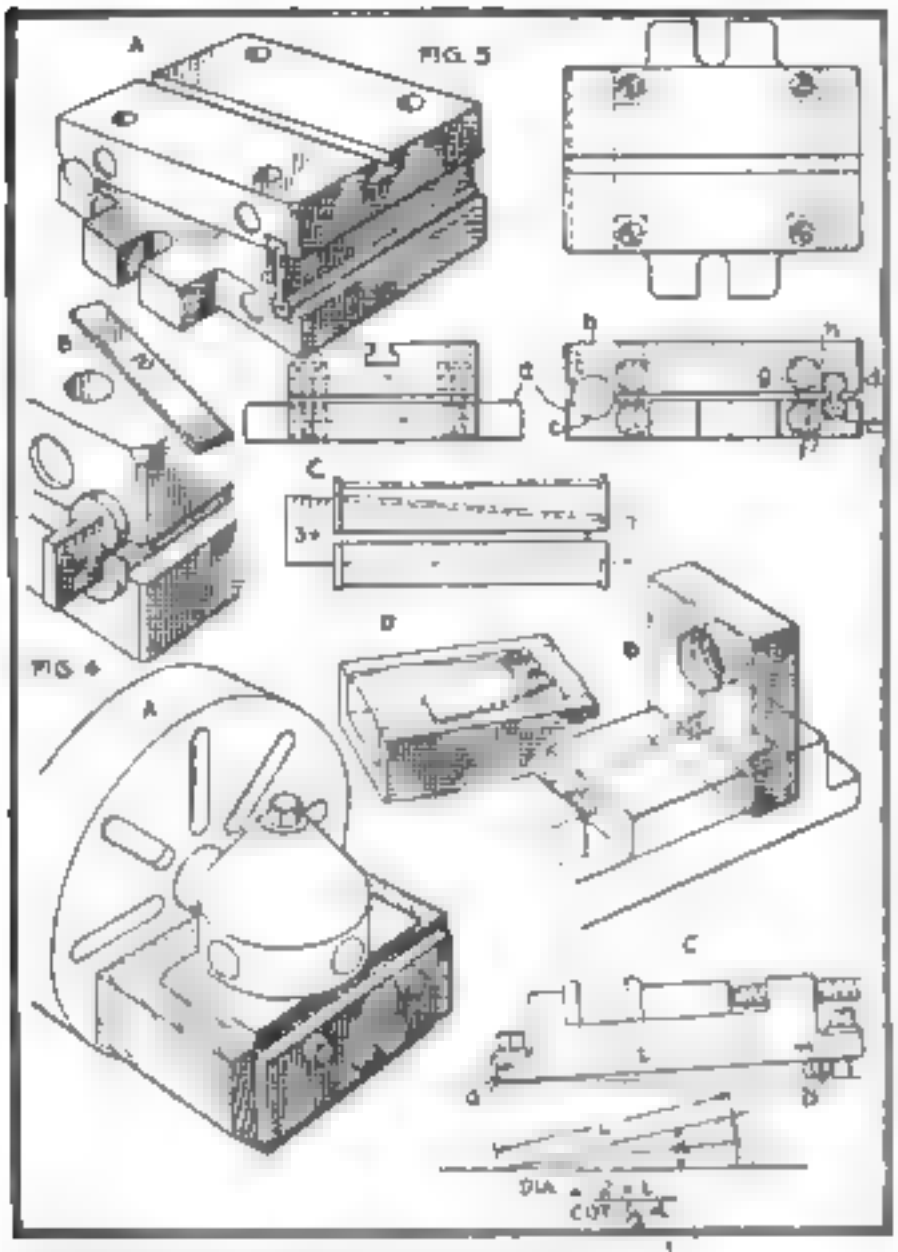

An adjustable-angle plate with range up to 30° (Fig. 3); various emergency measures (Fig. 4

be reduced to within a few thousandths by shimming. By using good-sized steel plates under the bolt heads as well as under the work, crushing of the wood is prevented.

Where there is room enough, a good angle plate can be improvised by the combination of a flat vise and a heavy flat plate similar to *B*. As ordinarily used, with the plate held only by the jaw, results are frequently disappointing, because there is not a solid enough hold. By removing the parallel jaws and threading the screws from the head jaw into the plate, the combination can be made quite rigid, and, if the vise is true and in good shape, accurate results may be obtained.

A quick way of aligning a machine vise at a fixed angle by means of a piece of round stock is shown at *C*. A small offset at right angles to the side of the vise is formed by grinding or milling along the front edge *a*, and two small pins are set near the opposite end at *b*. The pins must be larger than the diameter of the largest rod it is intended to use, which should not be over about one-tenth the distance *L*. The diameter of the rod is found by means of the formula. The use of clamping nuts with semispherical undersurfaces is advisable.

Very occasionally, some light hard-to-hold odd job can be done in a hurry by the use of nothing more than—gypsum. A simple article of this kind, set in such a gypsum holder, is shown at *D*. The work is temporarily fastened in the correct position in any convenient ring or other suitable frame-like scrap piece with a wad of gum or putty; then the gypsum is poured around to just below where the cut is to come. The clear space for the gypsum should not be too large, or it will shrink away in drying and be likely to crack loose from the work. It need hardly be said that only the lightest cuts can be taken when the work is held in such a way.

Editor's Note: Other problems relating to angular work were discussed by Mr. Simon in an article in the September issue. He will next take up the subject of hardening and tempering steel. The main topics previously treated were the handling and holding of work (December, 1928, January and February, 1929), avoiding distortion (March and April, 1929), measuring instruments (May and July, 1929), and optical aids (August, 1929).

Old Bill *Says*—

ALWAYS use the arbor press to drive a piercing punch or bushing into its holder.

A cheap way to patch broken teeth in a cast-iron gear is to drive in pins; a good way is to dovetail the job.

Consult your neighbor on a difficult job; two heads are better than one.

When roughing cast iron on lathes, planers, and boring mills, use a round-pointed hog-nose tool with a coarse feed.

Your kit of tools and their quality denote your ability: better check up on them now.

Welding machinery steel to high-speed steel for use in long cutting tools effects a substantial saving.

Before starting to bore a tapered hole, make sure the tool is on the center.

Give immediate attention to a slight injury by visiting the first aid room; it is a healthy practice.

Drill Extension Has Unusual Strength

THE drill extension shown below combines an unusual number of desirable characteristics. Held as rigidly as if it were solid, the drill is yet instantly removable. The holder can be made to be only twenty-five percent larger than the drill diameter, and the combination of the two will still have the full strength of a solid drill.

The extension is based upon the same broad principle that has for many years proved a success with magazine drills, namely the interlocking end. The tool steel shank *A* is reduced at *B* to a size from .001 to .002 in. larger than the drill diameter, and has the front end at *C* slabbed off to half the diameter.

The rear end of the twist drill itself is halved in a similar way to interlock with the tongue thus formed on the shank, and the two parts are aligned and held together by a sleeve *D*, which is firmly seated on the reduced portion of the extension shank.

A small pin shown at *E* serves merely to keep the drill from pulling out, and is readily removed by way of knockout holes *F* through the sleeve. Sleeve *D* may be made a light force fit on the extension shank, or the end near where it abuts against the shoulder on the shank may be sweated on, care being taken not to get any solder into the open portion where it would interfere with the joint.

It should be noted that only the extreme end of the drill seats against the end face of the extension and that the internal corner at the base of the tongue is made with a radius to avoid hardening strains, the straight edge on the drill tongue being slightly beveled off to make room.

By this construction, neither sleeve *D* nor pin *E* is subjected to any torsional stress, which falls only on the dovetailed ends of the drill and extension. As pin *E*

Twist drill with a simply made extension which holds it rigidly yet can be quickly removed.

is exposed merely to the slight strain of backing out, it should not be made larger than shown. The stress on the sleeve is from the center, acting outward. It is, therefore, well to see to it that the piece from which the sleeve is made has no seam or "cold shut," as in that case it would be apt to burst. It is not necessary to make the sleeve from an alloy steel and to heat treat it, but, if this is done, its size may be reduced even more.

Preparing the drill is a simple matter. The extension itself forms a gage to show when the end is formed just right, and when it is, the drill is slipped in place and the pin hole drilled, using the hole in the tongue on the extension as a guide.

Most drills ordinarily in use in the shop will be found soft at the extreme butt end. Should one be somewhat hard, the trouble can be overcome as a rule by using a few drops of turpentine as a lubricant, or, if necessary, by drawing the temper of the tongue.

Tools of Dependable Accuracy

IN their daily work, skilled mechanics are not always called upon to conform to limits of thousandths of an inch. However, even for their less exacting measurements, it is second nature for them to want tools of dependable accuracy.

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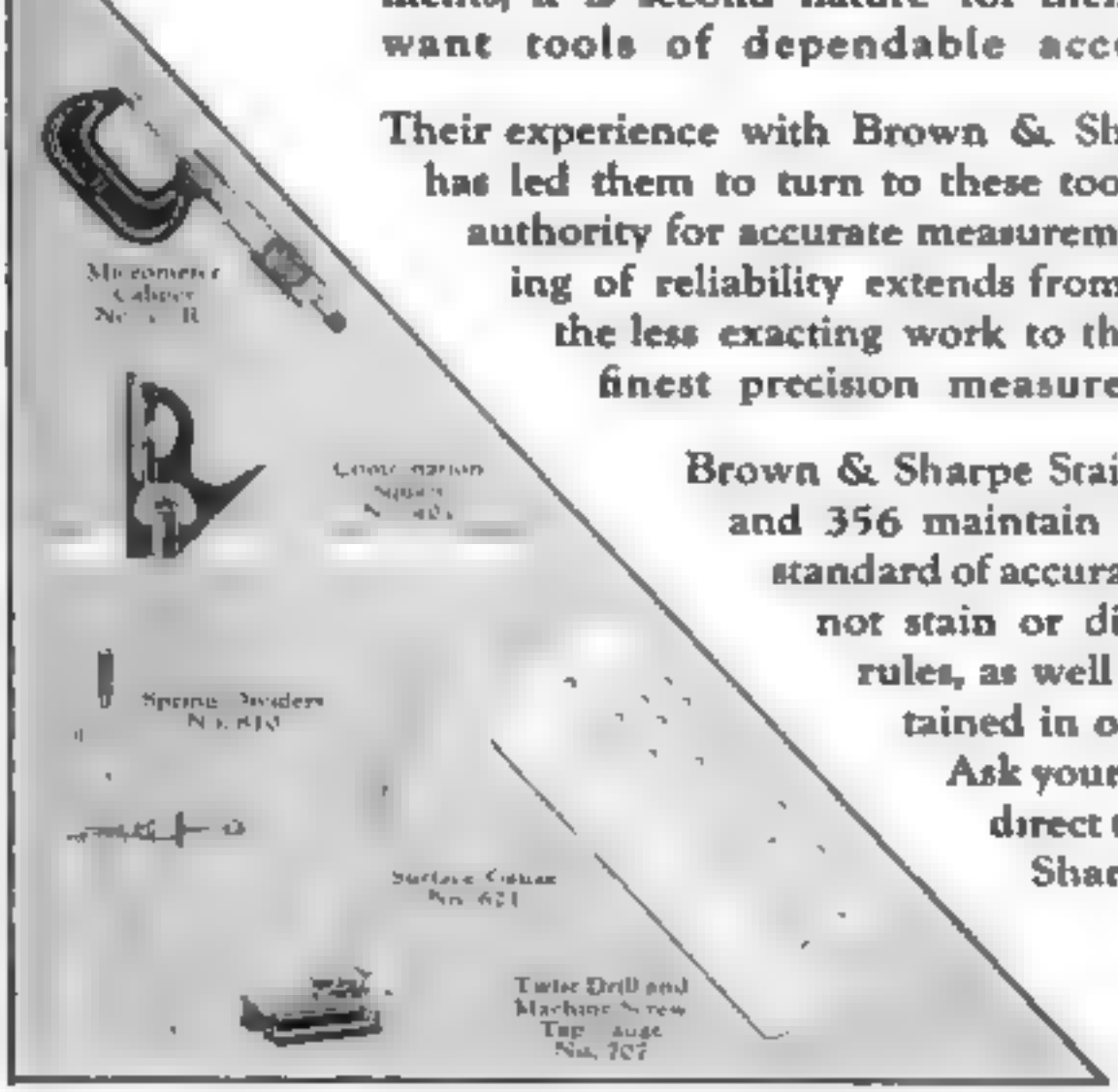

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B·S

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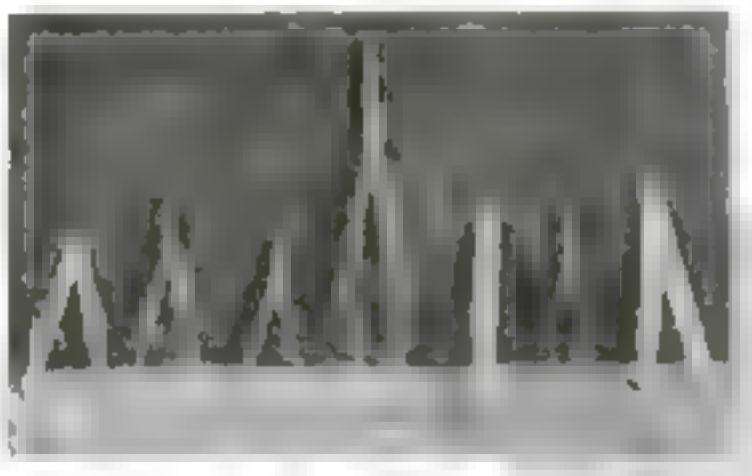
Fig. 1. The old blades are softened by heating them to a dull red and cooling them in dry ashes.

Tools *from* Old Hack Saws

By EDWARD THATCHER

MANY useful tools for the home workshop can be made from dull or broken hack saw blades. These blades are of fine tool steel and very hard, it is necessary only to heat them to a dull red and allow them to cool slowly, when the steel will be found soft enough to be filed and bent into various tools, which then may be hardened, tempered, and ground. For tweezers and saws, however, the steel remains just hard and springy enough after softening, in fact, no further hardening and tempering need be done except on cutting tools

There are two kinds of hack saw blades



[illegible]

blowtorch or in a forge or stove to a dull red, so that they show red *but no more*. Lay them on a brick to cool slowly, or, better still, thrust them under warm, dry wood or coal ashes and leave them for two or three hours.

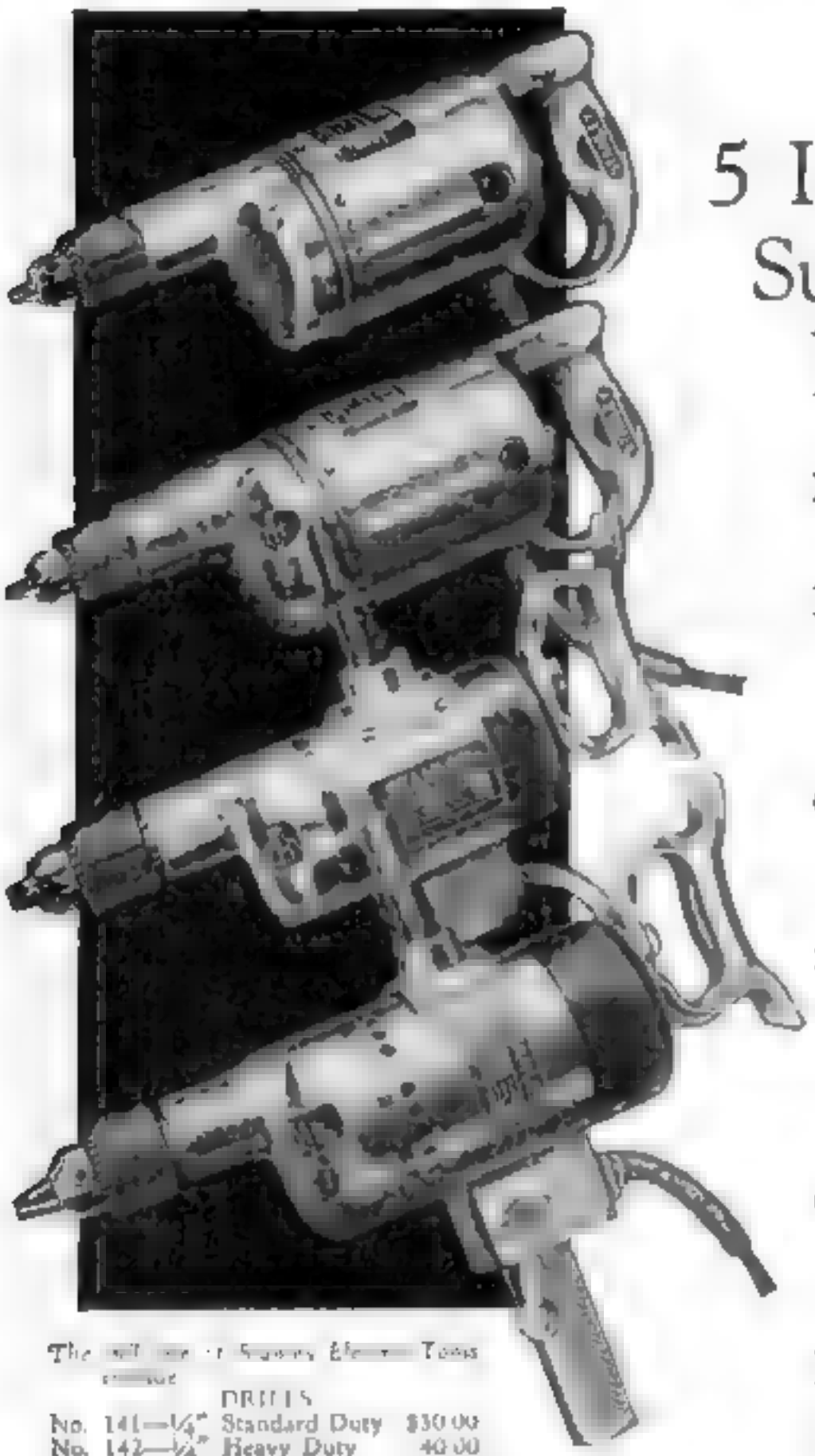
When the blades are soft, put them in a vise and use a fine file to remove the teeth, or grind the teeth off before softening if you prefer

The tweezers *D*, Fig. 2, are made from two 10-in. hack saw blades, with a rivet through the holes already in the ends. Place the riveted pieces in a vise, cut off the free ends just above the holes in them, and file the ends to long, tapering points. Make the bends with flat-nosed pliers Smooth up the edges with emery cloth and, if you wish, apply ammunition paint which prevents rusting and makes the tweezers [illegible] to hold on the scrub

Tweezers *B* are made from a

Fig. 2. Tools for ship model making and other delicate work: knives, saws, small grooving cutter, palette knife.

Stanley Electric Tools



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No.	182	3/8" Heavy Duty	68.00
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single 10-in. blade, which is softened and then heated again in the center so that the two ends may be bent.

Tweezers *E* are useful for picking up small objects. The blades are filed down, as shown, to the holes, and the rounded ends squared off.

Two short pieces of blade are riveted together to make tweezers *F*. The ends are left blunt and domed out from the inside with a center punch over a block of end-grain wood. These are for picking up ball bearings, silver balls in jewelry making, or other small round objects. Tweezers *C*, with in-bent square ends, will be found useful in pulling.

Fig. 4. Two special tools for cutting fine grooves to represent the planks or other divisions in ship models and similar work

Calipers *G* and dividers *I* are the remaining tools of Fig. 2. The blades of the dividers are given a trough shape by opening a vise to about three-quarters the width of the blade, laying the blade lengthwise over the opening, and hammering it with a cross-peen hammer or a piece of hardwood cut like a blunt cold chisel.

The cutting tools shown in Fig. 3, while not intended to replace regular woodworking tools, will be found advantageous in building ship models, wood carving, making linoleum patterns for block printing, and delicate work of many kinds.

THE knife blades *A* and *H* are made from unsoftened hack saw blades. Grind off the teeth and shape the ends; then, as a preliminary to tempering the steel, grind one side bright or polish it with emery cloth. Heat a flat iron bar red hot. Pick up a knife blade with tongs or pliers at the handle end or tang and rub the blade over the hot iron until the polished surface turns a very light brown for its entire length. At once plunge it vertically into water to cool. The blade then may be ground and sharpened.

Ordinary tool handles may be used for these tools. Drill a row of very small holes across the end of the handle, grip the tool or blade in an iron vise, and drive the handle on it.

When grinding thin tools be careful not to draw the temper. If you use an emery wheel, keep the work cool by dipping it frequently in water. An old-fashioned grindstone with water is really best for this kind of work.

The palette knife *N* is made in the same way except that it is ground thin toward the point to make it springy. It is softened to a dull straw color as just described. The short saw *J* does not require tempering. Left soft, it is about the hardness of most saws for wood. The keyhole saw *O* is made similarly except that the back is ground or filed to a taper towards the point. These saws may be filed and set when they become dull.

For the back saw *L* the blade is left hard, if it is to be used for metal. It is a 6-in. length of blade with a back of sheet iron or soft steel about ⅛ in. thick.

A piece of steel strap used on packing cases will serve for the back. Scribe a line down the center of each side, place it in the vise, and bend the steel over at a slight angle along the center line. Move the strip along and bend the remainder. Then repeat the process, bending the whole length over at a right angle.

LAY it on a flat anvil and bend to a trough shape by hammering along the upper edge. Insert the blade and squeeze the back hard against it in the vise. The back, being left 2 in. longer than the blade, forms the tang.

At *M* is shown a tool for making slight grooves to represent the planking on the hulls of ship models. It may be made from either a hack saw blade or a ten-cent kitchen knife. In the first case, use the rounded end of the blade, grind the sides to the desired thickness, soften the blade by heating, then file in several more teeth until they extend up on the curve of the rounded end. Then use a fine flat file to dull the points of all the teeth at this end slightly (see Fig. 5).

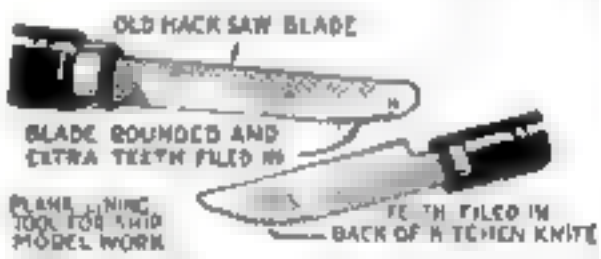

Fig. 5. Either an old hack saw blade or a common paring knife can be used for the tool.

To use the tool, planking lines are first drawn on the wood, then the tool is moved back and forth with a light pressure as in Fig. 4. For straight lines a ruler may be used to guide the tool.

The blade shown at *P*, Fig. 3, is used as a scraper.

In another article scheduled for early publication, Mr. Thatcher will tell how to make excellent little wood carving tools from old hack saw blades.

MECHANICS sometimes have trouble in trying to drill spring stock, especially if it is of good quality, even if they attempt to anneal it first. A simple expedient is to make a die by drilling a hole of the desired size in a piece of soft steel and to use a steel ball (from a bearing) as a punch. An arbor press or bench vise will push the ball through the stock and leave a perfect hole.—A. E. BODGE.

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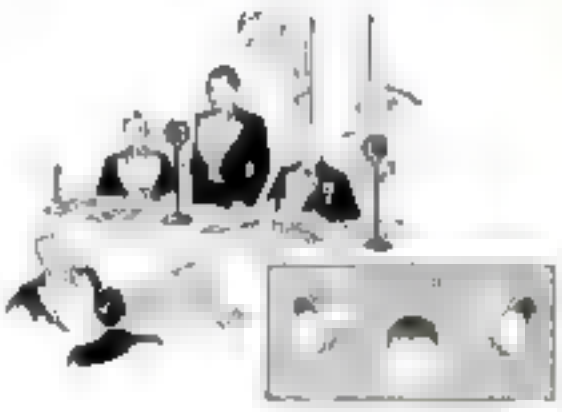

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Electrifying Old Kerosene Lamps

By HAROLD P. STRAND

IN CONVERTING oil lamps into electric lights, the main problem is to find a satisfactory way to support the cluster and stem which elevates the bulbs and holds the new shade.

As explained in a preceding article, Wiring a Vase for Lights, (July issue page 112), you can buy a ready made completely wired assembly to be screwed into the opening of the lamp. Such an assembly is satisfactory if only one bulb is desired, as when the old glass shade is to be used. This article, however, will describe two methods that provide a support for a new shade of any type preferred.

Special tools needed are ⅛- and ⅝-in. twist drills, and a ⅜-in. pipe tap and tap wrench, which perhaps can be borrowed. The materials required are a brass spun plate, a piece of ⅜-in. running thread pipe from 12 to 15 in. long, a ⅜ in. socket cap, a two-light cluster and stem, two standard pull-type sockets with ⅜ in. threaded caps, a ⅜-in. hard rubber bushing, a ⅜ in. lock nut, an attachment plug, and the necessary silk parallel cord.

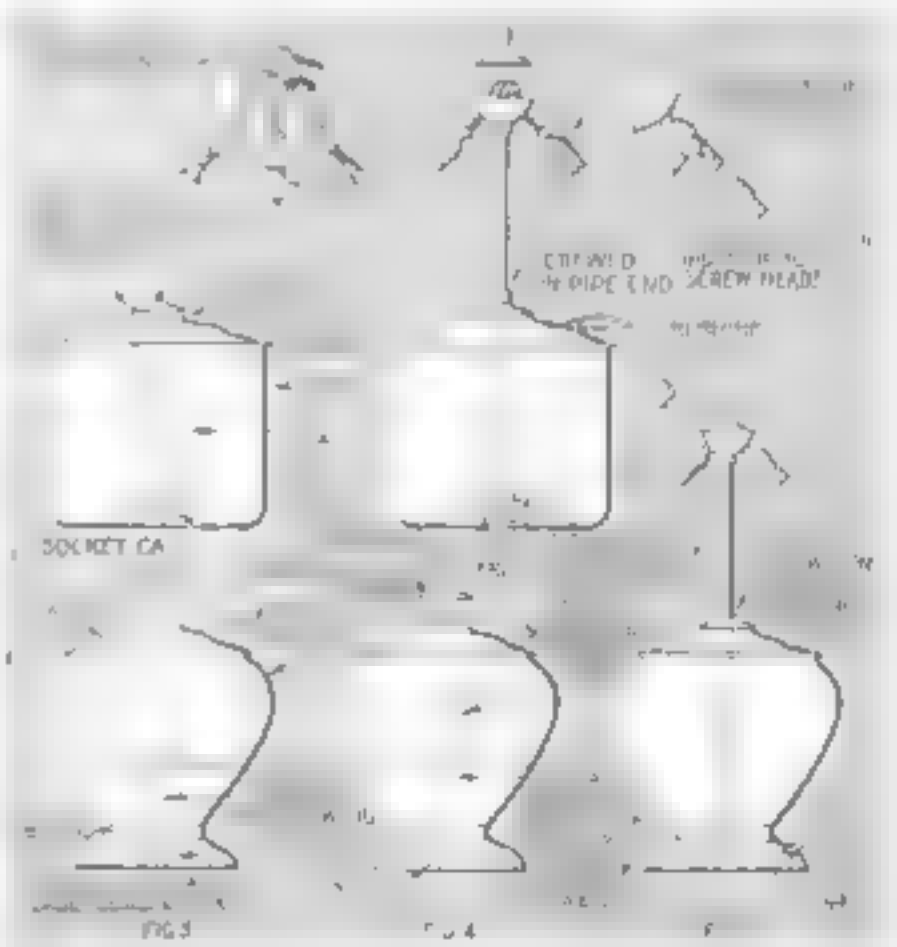
AFTER lifting out the oil tank see if there is an opening in the center of the lamp extending from the bottom of the well down to the bottom of the base. This will be the case if a removable rod holds the sections together. Assuming that there is no such passage and that none can be made, the first method (Figs. 1 and 2) is the practical solution. All the work is done on the tank.

Fit the spun plate snugly over the top hole in place of the burner. Then cut the running thread pipe in a vise with a fine-tooth hack saw so as to allow a projection of ¼ in. above the plate for fastening the stem and a sufficient projection below the tank for a socket cap to be screwed on. If the cap does not entirely fill the hole in the air shaft, use a large washer and a ⅜ in. lock nut. Screw the assembly together firmly.

Drill a ⅝-in. hole in the bottom of the tank and a ⅛-in. hole directly over it in the top. With a ⅜-in. pipe thread tap, cut some threads in the upper hole and screw in the ⅜-in. hard rubber bushing. Now pass the cord through and make the connections as shown in Fig. 2. Be sure to solder and tape the two joints carefully and press them down in the cluster body. Attach the sockets in the usual manner and connect an attachment plug at the end of the cord.

The second method (Figs. 3 to 5) is used when a ⅛-in. pipe can be carried all the way down to the bottom of the lamp. Cut off the pipe, leaving enough at the top to project over the spun plate and enough at the bottom for a washer and nut, as shown in Fig. 4. Be careful to ream the burr from the inside of the pipe after cutting it off.

The cluster is screwed on, and the cord is passed up the pipe and connected as in the first method. The lower end of the cord is usually carried out through one of the open holes or ornamental filigree work in the base, but, if none exists, a ⅛-in. hole is drilled where desired, tapped with a ⅜-in. pipe tap, and fitted with a composition or rubber bushing.



One standard type of oil lamp can be fitted with a cluster and stem as shown in Figs. 1 and 2, and the other chief variety as in Figs. 3 to 5.

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Decorating *with* Kalsomine

By F. N. VANDERWALKER

THERE are many ways to handle kalsomine simple and inexpensive finish as it is, so as to gain uncommonly decorative effects. It should be remembered, however, that most of these decorative wall finishes can be carried out in a more permanent form by using either prepared flat wall paints or white lead and flatting oil tinted to suit.

A mottled wall finish is illustrated in Fig. 1. Three colors of kalsomine were applied at one operation and all blended together. The wall was sized as usual with a weak solution of glue and water—about 1 lb. of glue to 1 gal. of water. When this had dried, pots of kalsomine colors were mixed up and a brush provided for each, they were ivory, a light, bluish gray, and a light, dull red.

A starting was made at the top of the wall and a stretch about 1 yd. square coated in, patches of each of the three colors being daubed on the wall. Then while the colors were wet, they were quickly stippled with a wad of newspaper; that is, the newspaper was crumpled into a ball about the size of a large sponge and the wet colors were patted with it to blend them together. The newspaper wad was turned frequently in the hand to bring new creases and patterns into contact with the surface, and only enough stippling was done with it to make an attractive pattern.

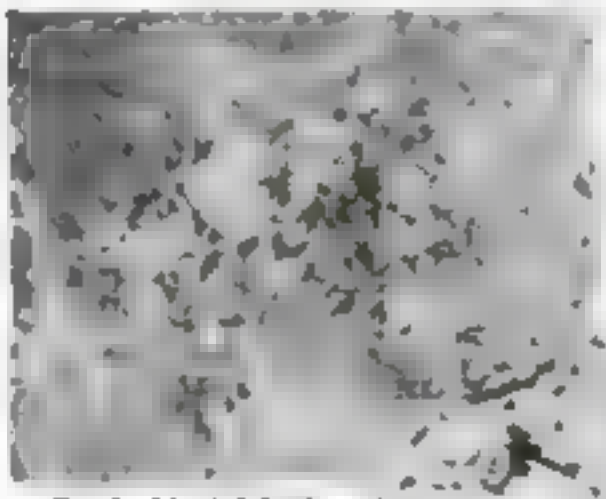

Fig. 1. Mottled finish made with paper wad.

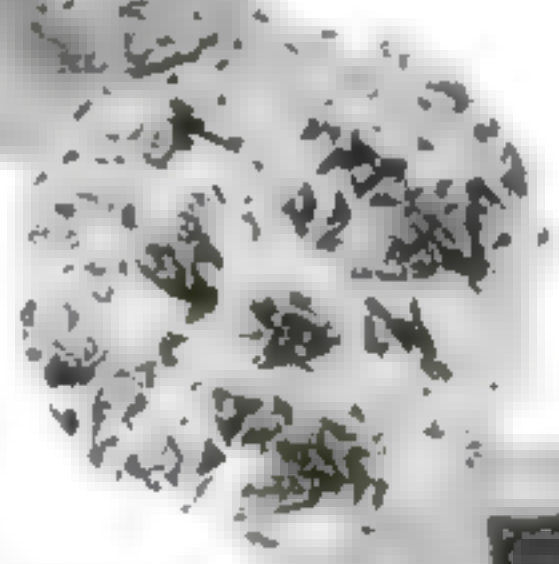

Fig. 2. A roll of newspaper was used for the effect at the right.

Then another space 1 yd. square was done in the same way. This procedure was repeated until the wall was completed, the work being carried on from the top to the bottom of the wall and from left to right.

The ceiling in a room finished in this way may be a plain color—one of the colors used on the wall—or it may be in a two-tone effect produced from two of the wall colors by brushing one of them on as in any ordinary kalsomine job and stippling the other with a sponge. The second color is first brushed on a board and then picked up on the sponge.

GIVING a kalsomine painted wall a mottled effect by spattering with a brush.

A different pattern is shown in Fig. 2. This was made black on white to insure a clear photograph, it is, of course, infinitely more interesting when done in low contrasting colors or two shades of the same color.

The wall is first coated with a ground color kalsomine and allowed to dry. Then the second color is mixed as the first and a brushful at a time is spread out on a board. A double sheet of newspaper is crumpled up into a roll and is pressed

Fig. 3. In producing a spattered finish, the handle of the kalsomine brush is jarred smartly against a stick.

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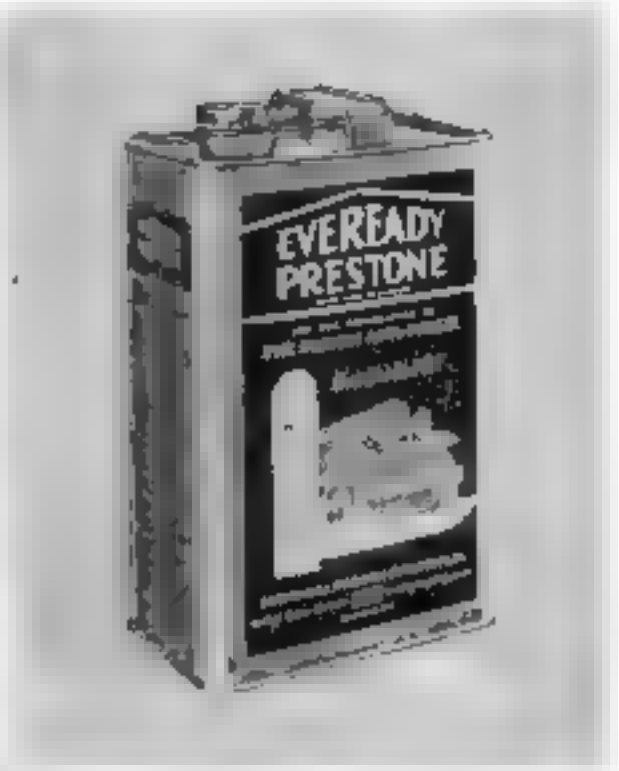

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into the color on the board. The roll then is used to roll the color on the wall to form a decorative pattern

One, two, or more colors may be applied in this manner The ground color may be very light with dark overcolors, or the ground color may be a dark shade, upon which light tints are applied with the paper wad

To produce a radically different pattern, the second and third colors may be spattered on instead of being applied with a sponge or newspaper wad. The ground color may be light or dark, and should be dry before the brushing colors are applied Exceptionally interesting finishes are obtained by having the ground coat very dark, in fact, black is sometimes used for the ground for modern decorations, because on it the most brilliant of reds, blues, greens, and yellows do not appear too loud or gaudy

The overcolors are mixed as usual Then a 4-in. flat wall brush or, better yet, a Dutch kalsomine brush is dipped into one color and wiped out on the side of the pot. Take a heavy stick about 2 ft. long, hold it about 1 ft. from the wall to be spattered, and hit the metal binding of the brush—the handle—on the stick to jar the kalsomine color out in minute round spatters (Fig. 3). Try this on some old wall board or newspaper first to get the hang of it.

You need but little color in the brush. By holding the brush at various angles, you can control the direction of the spatters.

Many color combinations are possible in this finish. A safe method is to apply a light or dark ground color and then spatter it with two or three shades or tints of the same color which are a few degrees lighter or darker. A single contrasting color may be added to give life, if desired. For instance, an ivory ground color spattered with cream and tan is interesting, but a contrasting color such as dull red, blue, black, or green may be added.

Gold or silver bronze mixed with glue and water or with one of the regular bronzing liquids are also used in these spatter finishes.

Fig. 4. Candle design stenciled on a bedroom wall to ornament the mottled kalsomine finish.

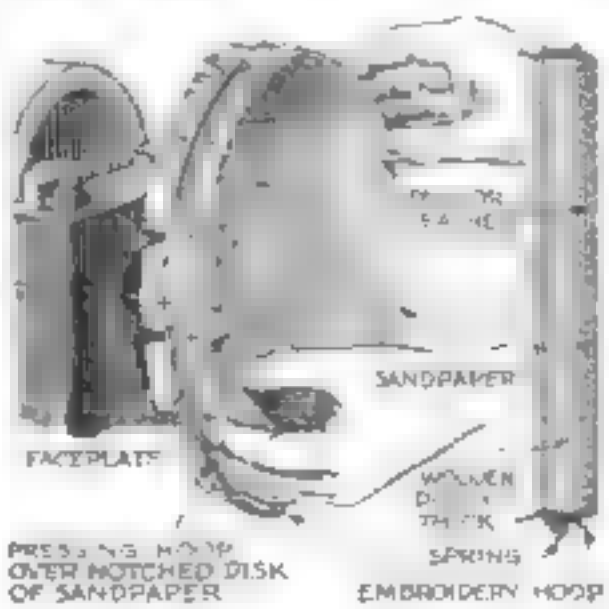
It is essential to cover up with newspapers or cloth any wood trim, such as door casings and baseboards, and the floor, while doing such a job, because the spatters cannot be controlled sufficiently to keep the trim clean. The papers may be stuck on to the wood trim with glue, adhesive tape, or library paste, or may be held in place with pins.

Stencil designs can be used effectively in connection with mottled and blended kalsomine finishes on walls. Suitable designs may be placed on top of the ground coat of color and then the second or other top coats applied right over the designs in order to subdue their contrast. Figure 4 shows the use of a simple stencil motif of a candle in a bedroom finish. It was placed at random, not at regular intervals.

Mr. Vanderwalker, who is one of the leading authorities in the painting trade, told how to apply plain color kalsomine, in the January issue, page 78, and how to obtain various stippled effects, on page 102 of the June issue.

Embroidery Hoop Improves Sandpaper Disk

WITH the aid of a large metal embroidery hoop of the kind having a spring to keep it taut, you can make a practical and convenient disk sander for use on a small lathe or an electrical home workshop.



Disk sander on which the sandpaper is held securely by means of a metal embroidery hoop.

After buying the hoop at a ten-cent store or a department store, screw a block of wood about 1 in thick to a faceplate and turn it to a diameter slightly larger than the inside of the metal ring. Cut the sandpaper about 2 in. larger in diameter and notch each piece as shown so that the edges can be bent over and fastened to the wooden disk by means of the embroidery hoop. Although not absolutely essential, felt or soft leather may be glued to the face of the wooden disk to make it softer

This type of disk sander has two advantages; the entire surface is free for sanding, and the sandpaper can be quickly changed from coarse to fine as the work progresses or whenever desired. Furthermore, the work required to make the sander is trifling, and the cost for materials amounts to little.—A. E. McCALL.

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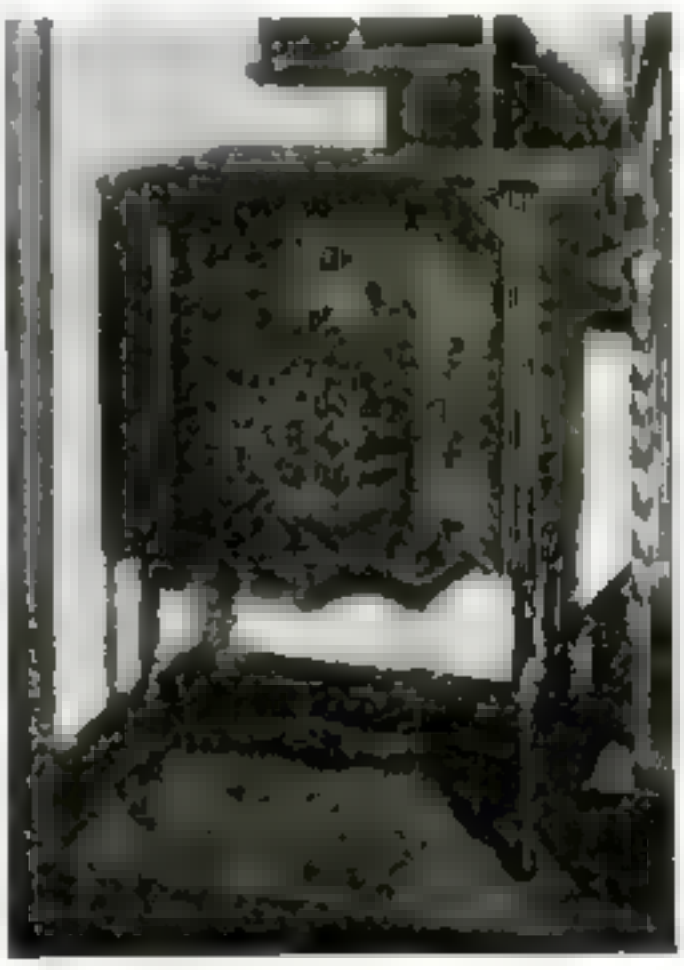

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This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Casting Model Yacht Keels

By

J. G. PRATT

ALTHOUGH model yachting has become a national pastime and much has been published on both the building and the sailing of miniature boats, little attention has been paid to casting keels, with the result that this work is generally turned over to a foundry. Yet the builder of a model yacht takes greater pride in his work if he makes everything, including the keel, with his own hands.

The 14-lb. keel for the 52-in. sloop shown in the accompanying illustrations was made by a method any beginner can follow successfully.

Pouring the lead keel of a large racing yacht model. The mold inside the wooden box is made of plaster.

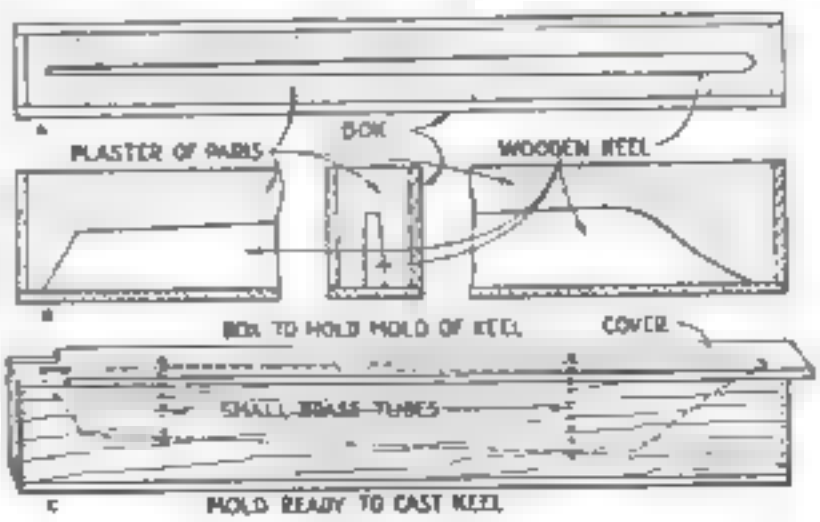
Fashion a pattern of the keel of white pine as shown at *B* in the drawing. One with a straight side is easier to make and has been recently pronounced more efficient than the bulb shape. As lead weighs about twenty-six times as much as pine, you can estimate what the weight in lead will be.

Float your boat in a tub and pile in 1-lb. bags of sand to find where the weight should be to give it the proper trim—that is, with ½ in. more freeboard at the bow than at the stern. Then build up or shave down the pattern accordingly, and sandpaper the wood. If there is any taper up and down, the keel should be thinner toward the bottom.

Screw together ¾-in. or thicker boards to form a strong box large enough to house the wooden keel and leave at least ½ in. in all directions (except at the top), as in the diagram marked *A*. With the box upside down, remove the bottom and insert the pattern as at *B*. Coat the sides of the wood with soft plaster of Paris; then pack the box full of plaster. Screw on the bottom and leave the box bottom up for an hour or more.

A 52-in. sloop constructed by Mr. Pratt. It has a 14-lb. lead keel, cast as told in this article.

The plaster mold, which has been cut open longitudinally to show its shape, and the rough casting.



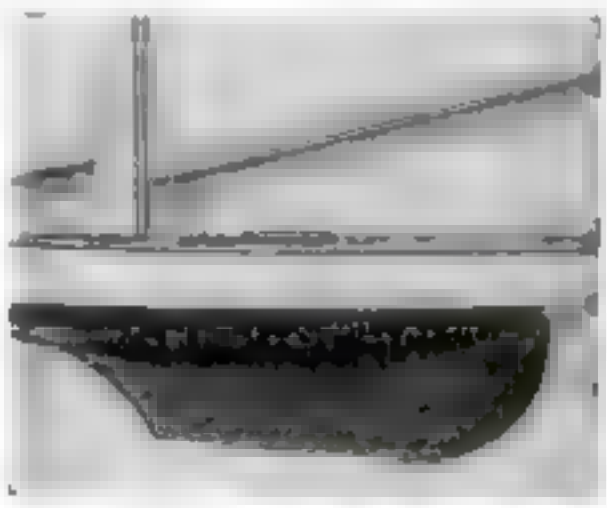
How the wooden pattern is placed in a box and covered with plaster of Paris, and how the mold is finally prepared for pouring.

When the plaster is dry, remove the box top and withdraw the wooden keel. A grip can be secured by inserting a screw at each end.

To save trouble in drilling holes for the bolts, sections

of ⅝-in. metal curtain rods or other tubes can be used as indicated at *C*. Get the exact positions by placing the wooden pattern on the boat and marking both where the bolts should go and their proper angle. The tubes are sunk ¾ in. in the bottom of the plaster mold and are projected through the box top. Care should be exercised in centering them accurately.

The top is so placed that 1½ in. of the



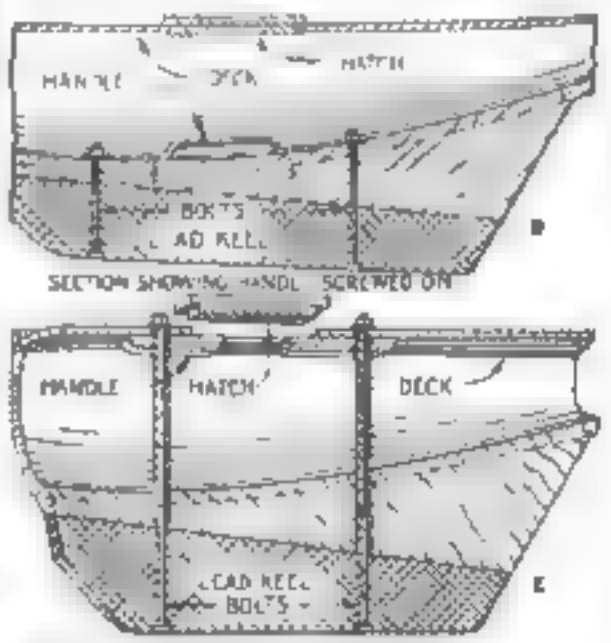
The finished keel in place on the model. The lead is smoothed with plane and sandpaper.

mold will be left open at one end for pouring the lead.

When the mold is thoroughly dried out, it should be blocked up securely at an angle of about 30°. Melt sufficient lead to fill the mold at one pouring if possible; otherwise do the pouring in two or more operations, as in the case of the keel illustrated. The sections weld themselves together, and a soldering iron will smooth out all trace of the crevice. In smoothing the keel, use a small iron plane and sandpaper.

Up to about 14 lb., it is satisfactory to bolt the lead permanently to the ship's keel, as indicated at *D*, and waterproof the bolt holes with white lead putty. For a heavier keel, however, it is more convenient to have tubes or "wells" from keel to deck, as at *E*, so that the bolts go clear through the ship. The keel then can be easily detached at the deck to lessen the strain on the hull when being carried.

In the latter case the handle or lift should be fitted on the underside of the deck, crossing the cockpit.



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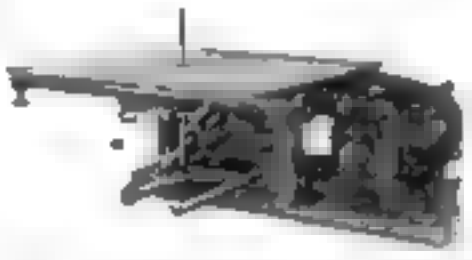

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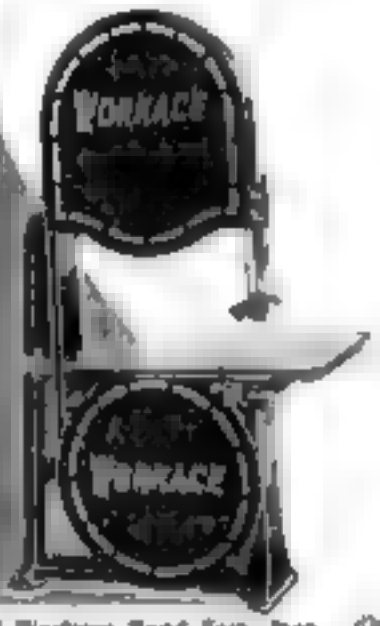

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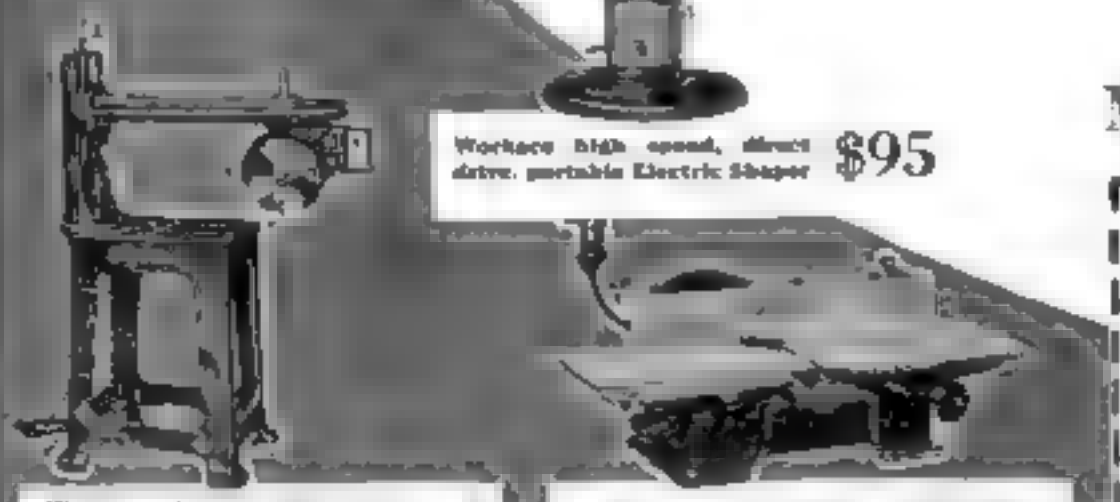

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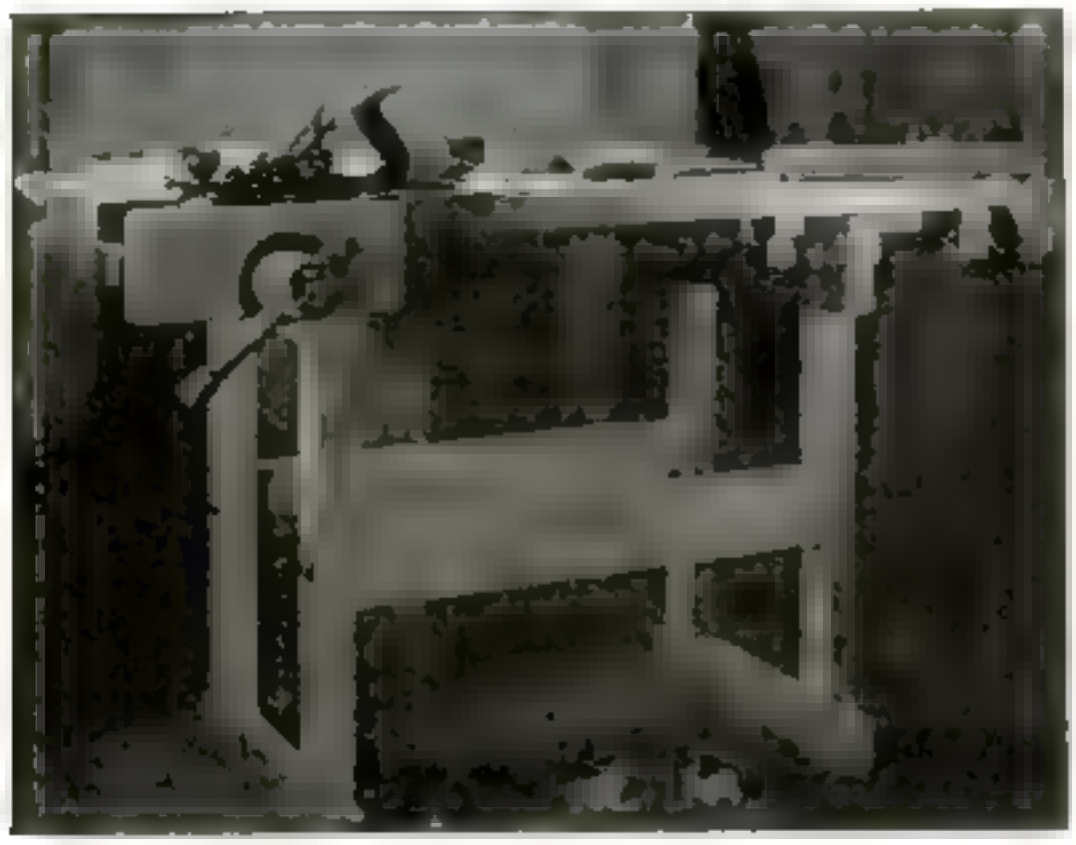

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Nickel that has become dull—that is, severely tarnished—requires a mild abrasive like whiting, precipitated chalk and similar fine scourers. These may be powdered pumice, of which various grades may be obtained, or tripoli (also known as diatomaceous earth, infusorial earth, diatomite, and kieselguhr). The finer and softer the powder is, the less chance is there for destroying the plating or scratching the surface. When the plating is broken, replating is the only remedy.

Pouring polish into small molds to harden.

It makes absolutely no difference what kind of polish is used, whether in liquid, paste, or solid form. The dry powder may be used if dusted on a moist but not wet piece of clean cloth. Rub thoroughly and dry with a clean rag.

A more convenient liquid polish may be made by filling a bottle (of about 2 or 3 ozs.) half full of the powdered abrasive and covering the powder with denatured alcohol. Shake the bottle and fill it with water. This polish must be shaken thoroughly before being used.

A good but inflammable polish may be made by dissolving 1 oz. of paraffin in 7 ozs. of gasoline and adding 2 oz. of abrasive, such as F or FF pumice—a grade that is not too fine. This will not only polish the nickel or other metals but also will provide a very thin protective covering of paraffin.

A solid cake is perhaps the most convenient form for the polish. This may be most easily made by mixing thoroughly two parts of plaster of Paris with four parts of abrasive. After the dry powder has been mixed, add water to form a thin paste and pour into forms to dry and harden. To use this polish, moisten a rag, apply it to the cake to take off a little, and then rub the metal.

Acids cannot be recommended. They do take off the worst of the tarnish and even corrosion, but usually the corrosion is back worse than ever in a short time. When the under metal has been exposed, renickeling is all that can be done.

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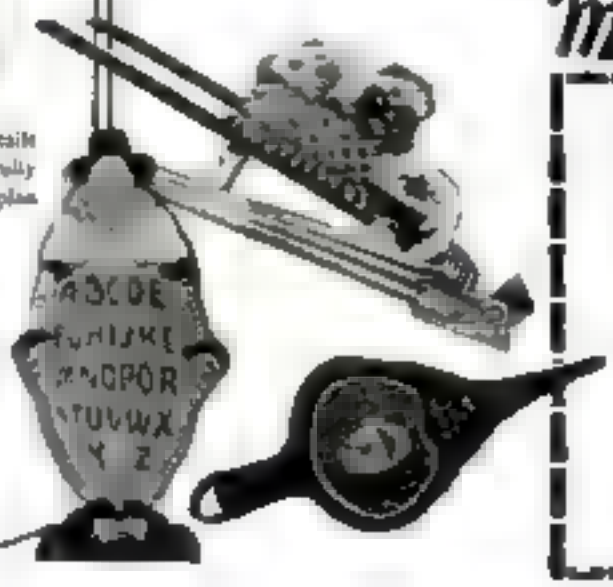

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(Write in Pencil—Ink will blot)

Machine for Molding Edges

Built at Relatively Low Cost, It Gives Homemade Furniture a Professional Look

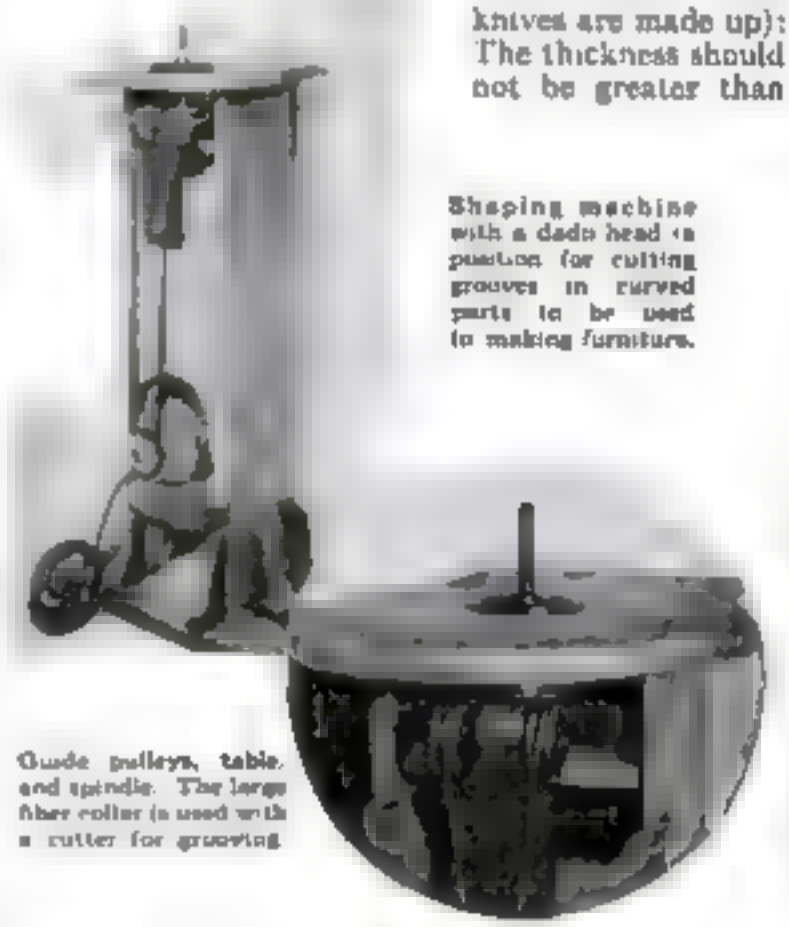
By W. Clyde Lammey

NO DOUBT every home worker at one time or another has viewed with certain envy the neatly molded curved edges that are a characteristic of many fine pieces of furniture. Such a molding is comparatively easy to form where it is straight, but when it must be applied to curved edges, it gives a hard challenge to every workshop enthusiast.

The ordinary commercial type of shaper or former used for such work has one or more vertical spindles extending above a smooth-surfaced table. The spindle carries the former knife and is driven by a friction mechanism that allows reversing it at will, which is often necessary where the knife must cut across the grain.

Two types of cutters, made in a wide range of shapes and sizes, are generally used on these machines. One of these is known as the "wing" cutter and is reversible, that is, it has four edges that cut while rotating in either direction. The other is a "solid" cutter and cuts only one way, but it requires less power and is used for all but the finest work.

The amateur woodworker who already has a motorized shop and is accustomed to using woodworking machines can make this former at relatively small cost and thus open for himself in a moderate way a field seldom touched by any but artisans with the best of equipment. Only a skilled woodworker should use the machine, however, because the exposed cutter revolves at high speed and is exceedingly dangerous. The machine must be operated by a careful, cautious, and well-trained mechanic.



Shaping machine with a dado head in position for cutting grooves in curved parts to be used in making furniture.

Guide pulleys, table, and spindle. The large fiber collar is used with a cutter for grooving.

AN ORDINARY polishing head of good quality carries the former knife. The one used by the author cost four dollars. Get two very small compression grease cups with a tap to suit and remove the spindle, ream the oil holes to size, and tap out for the cups. A positive means of lubrication is absolutely essential as the spindle must operate at high speed—not less than 3,000 revolutions per minute for the best work.

Before buying a cutter, the worker should consider the kind of molding that will best serve the need. As a rule a cutter of the form known to woodworkers as "O G." will be found to give the widest range of usefulness where but one is used. Raised and lowered on the spindle by means of washers, it may be adapted to different thicknesses of stock if the need arises. The solid cutter is the least expensive, does good work, and in the size adapted to the ⅝-in. spindle of the polishing head ordinarily will cost from seven to twelve dollars. It is made from high-speed steel and may be ground at any time without changing the shape.

Two things must be made sure of when purchasing the cutter (which may be obtained without difficulty from any woodworkers' tool works where these knives are made up): The thickness should not be greater than ¼ in. or less than 3/16 in.—¼ in. is about right. The lower diameter of the cutter should be 1¼ in. to make the proper shoulder on the lower edge of an "O.G." cut. If the cutter cannot be obtained exactly this size or it is otherwise desired to have it smaller, the collars may be filed to fit neatly by hitching the motor on after the head is in place, but use the utmost care in filing.

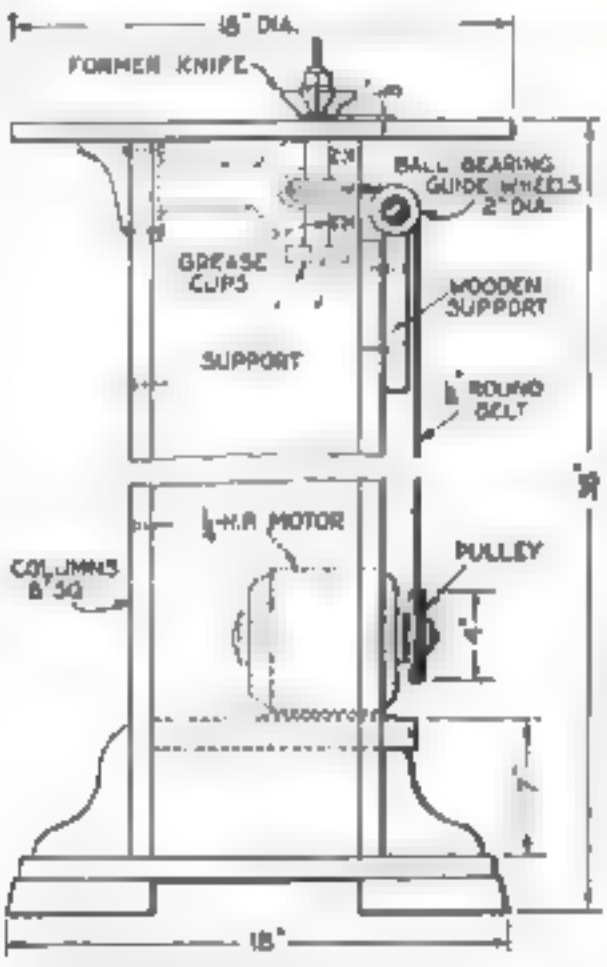
Put together the base and pedestal in a substantial manner with screws and glue as shown in the drawing marked Fig. 1. Leave the piece on the belt side off for the time. An opening for the motor is cut in this piece, and the space below the shelf is left open so that the bolts may be tightened and loosened easily.

In mounting the polishing head, the inside collar on the spindle (the lower collar when the spindle is vertical) should extend ¾ in. above the surface of the table as shown. While this dimension is arbitrary and may be more or less, an "O.G." knife 1⅛ in. thick cuts a symmetrical molding on ⅝-in. stock—which is the ordinary thickness of so-called 1-in. hardwood—when mounted in this way.

The small shelf illustrated on page 118 shows the work done by a knife of this description and size. The extension of the collar above the table is important, as in practice the stock is held against it when making the cut, thus enabling the operator to keep control of the work at all times. It is possible to work in any circular form the diameter of which is not less than the spindle collar.

THE maple support under the lower bearing is bored to fit the spindle and serves to steady the head while in operation. Ream out the holes in the iron base and bore two others for small bolts, as screws are likely to work loose and cause trouble. No vibration of the head can be tolerated.

In the drawing marked Fig. 2 is shown the ball bearing guide pulleys adapted



ASSEMBLED SIDE VIEW - FIG. 1

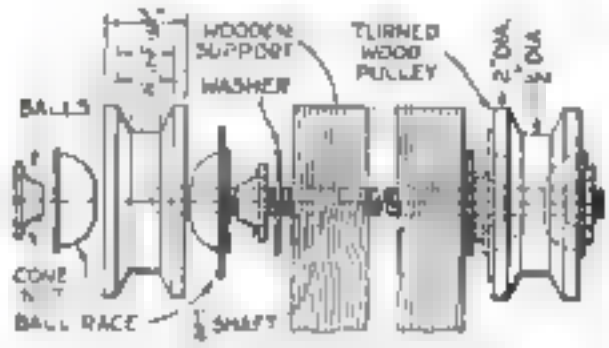
How the grinding head and motor are mounted in a neat, substantially built wooden pedestal.

from the bearing assemblies in two discarded roller skate wheels. The wheels selected should be of the double ball-race type. Cut through the thread of the skate wheel with a hack saw and pry off the rim, which will release the bearing assembly. Turn the guide pulleys from tough hardwood, such as maple. Bore them (while still on the lathe faceplate) so that the cone races will fit snugly on both sides of each pulley. Cut the threaded shaft out of the skate frame with the hack saw and fit it snugly through a piece of wood of the form shown in one of the photographs. Assemble the wheels on this shaft, taking care to have the inside cone nuts tightened against the wood so as to hold the shaft securely. Lubricated with a little heavy oil, the pulleys will run silently and without vibration under a light belt.

Have the stock carefully sawed to the outline desired and the curves all perfectly true, otherwise the molded edge will be wavy. By using fiber collars of different sizes, it is possible to make diffi-

cult cuts in two or even three operations.

Always have a firm hold of the stock before presenting it to the knife. Be sure that it is flat on the table and work slowly to prevent splintering or otherwise haggling the edge. Take the utmost care to keep your fingers away from the cutter and be sure to roll up your sleeves before starting work. Allow no boys to operate the machine.

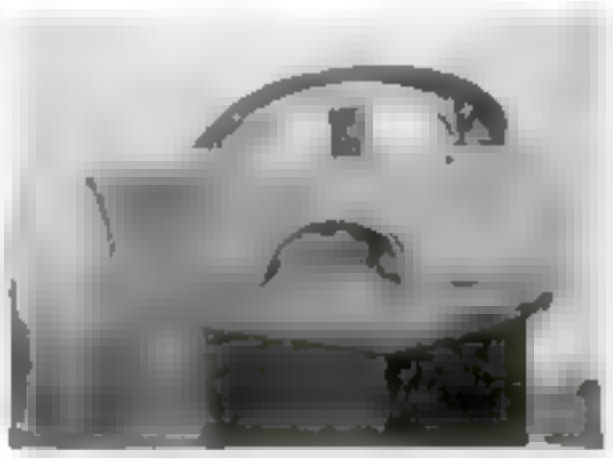


BALL BEARING GUIDE WHEELS - FIG 2

Ball bearing guide pulleys made from parts taken from wheels of discarded roller skates.

If you own a small bench saw, the special dado heads will generally fit the ½ in. spindle of the polishing head. If this is so, it will add materially to the versatility of the machine. If no dado is available, a small grooving saw may be purchased for a nominal sum and will be useful for internal grooving and rabbeting.

When either saw or dado is used, get a piece of ½-in. fiber, and if the dado is 4 in. in diameter and the groove must be ¼ in. deep, cut the fiber to 3½ in. diameter and bore a hole of such size that it will fit the spindle collar, as shown in one of the photographs. Be sure that the fiber is a true circle, otherwise the cut will vary in depth. Hold the stock (as in making the curved top of a mirror frame, for instance, or where it is necessary to let panel work into a curved frame) against the fiber collar, and an internal groove will be cut



Two examples made with the homemade former. The upper piece shows internal grooving done with a dado head; the lower is a shelf.

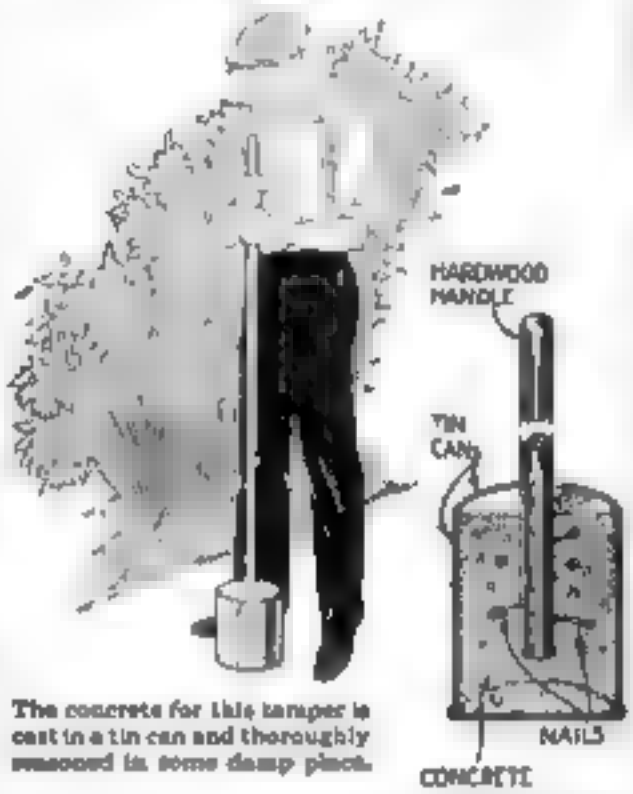
in the work as neatly and accurately as could be desired. By means of washers on the spindle proper the position of the groover can be changed to any height within the limits of the thread.

If an ordinary T-handle of the type furnished with many lathe chucks is replaced with a handle made on the order of a crank, the operator can change jaws in half the time usually required. When a part is being chucked, the crank wrench can be operated reasonably well with one hand while the work is held with the other.—R. M. Koch

General Utility Tamper Made of Concrete

CONCRETE can be used in making an inexpensive tamper for cement work and odd jobs about the garden. All that is required is a tin can 5 or 6 in. in diameter, with the top removed

Drive several nails into the end of a suitable hardwood handle so as to form radiating projections. Insert the stick



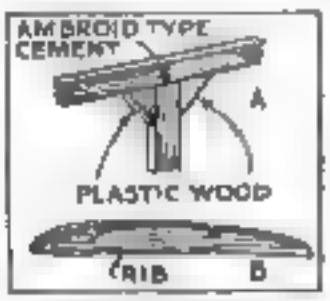
The concrete for this tamper is cast in a tin can and thoroughly seasoned in some damp place.

into the can and pour thoroughly mixed concrete around it. See that the handle is placed as nearly in the center of the can as possible and that its lower end is 1½ in. up from the bottom

The mixture should harden at least twenty days in a damp place, when it will be firm and much more tough than ordinary concrete. This is important, because the tamper must stand severe battering at times. It is ideal for driving stakes, tamping soil, leveling spots about the lawn, and similar uses.—H. W Swope.

Hints on Model Airplanes

A STRONG type of joint for light model airplanes, especially those having a framework of delicate bamboo members, can be made as shown at *A* The members are butted together and fastened with an ambroid type cement then reinforcing fillets of a plastic wood composition are added. Wing spars less than half the size ordinarily used are quite practical if the ribs are cut as shown at *B*. The construction is very strong and light. The silk or paper covering can be stretched tightly on the frames and the usual warping effect of the dope is minimized.—Edward W. Blackman



A reinforced joint and a rib for a light wing.

Some home workers fail to realize the importance of tool quality and tool condition. A skilled mechanic finds that even with the best tools his skill is taxed to produce work of first-rate quality.

Comical Ash Trays for Bridge Fans

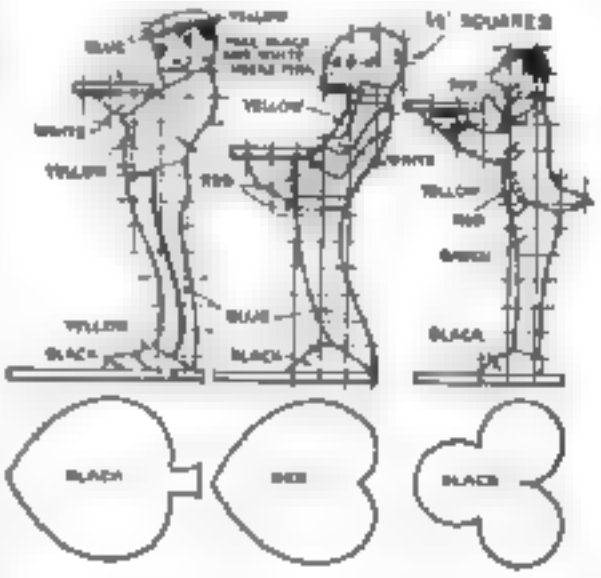
THE accompanying designs for an amusing bridge table set were submitted by George Gordon, Jr., of the Congress High School, Bridgeport, Conn., in a contest conducted by the Educational Department of POPULAR SCIENCE

A colorful bridge table novelty cut from thin plywood or metal.

MONTHLY for teachers of shopwork. Mr Gordon won first prize in the advanced metalworking division of the same contest with a design for andirons, which will be published in another issue

The ash tray figures can be laid out in ¼- or ⅜-in. plywood by enlarging the squares, and cut with a fret saw. The bases are similarly cut out in heart, club, and spade shapes.

To complete the set, Mr. Gordon made a fourth figure similar to the first but a trifle shorter and placed it on a red diamond-shaped base.



Three figures in the bridge set. The fourth, not shown, is only a shorter version of the first.

Tin covers will serve for ash trays, or suitable trays may be purchased for a few cents each

These novelties also can be made of ⅛-in. sheet brass, in which form they have proved a successful project in advanced metalwork classes.

Much time may be saved in using steel stamps if a small notch is ground on the top side of each figure or letter to indicate when it is in the proper position for stamping.—R. M. KOCH

Mounting a Small Shop Motor

The motor slides along the lathe bed and can be used to drive any of the small bench machines

IN MY home workshop I run several bench woodworking machines with one motor, as shown in the accompanying illustrations. The motor is mounted on a wooden sub-base, which slides on the lathe shears or bed and may be clamped solidly at any desired point. This system allows me to have almost any desired length between lathe centers, for turning, as both the tail- and the headstock are movable.

The diagram below is of the end of the bench with the motor belted to the saw. If the rotation of the motor is not readily reversible, the belt must be crossed.

The motor sub-base *B* is made of hardwood with the grain crosswise to the shears *J*. The guide *C* is screwed to *B*,

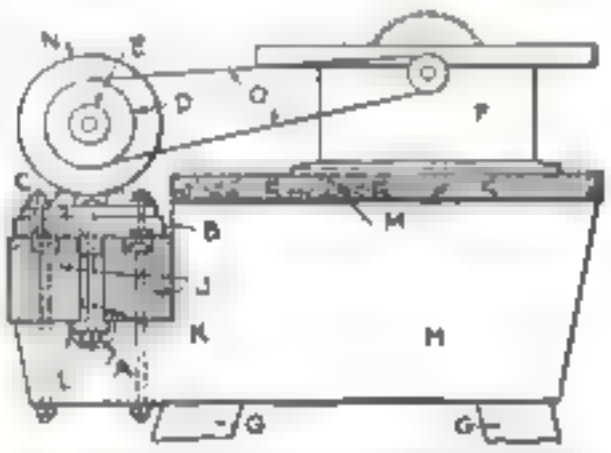


Diagram of end of bench showing the lathe shears with the sliding motor belted to a saw

which can be clamped wherever necessary by the nut *A*. The other parts in this particular set-up are as follows: *D*, 4-in. flat face pulley; *E*, 2-in. grooved pulley; *F*, saw table, *G*, legs to floor; *H*, 2-in. thick hardwood framing; *K*, hardwood guide block; *L*, ⅛ by 2 in. iron of required length; *M*, 1¼ by 6 in. tongue-and-groove stock; *N*, motor, *O* belt to bench saw.—George W. Royer.

Do not use sappy wood, under any circumstances, for repairs to outside woodwork. If moisture can get at it, such wood will rot in a very short time. Sound knots are not to be rejected, but be sure they form an integral part of the board.

Extra Drawer Fitted into Sideboard

By L. M. ROEHL

Fig. 1. Linen drawer or tray built to occupy unused space in a sideboard compartment.

SINCE the upper half of the space in the side compartments of the ordinary sideboard is rarely utilized, it is often desirable to make an extra drawer as shown in Fig. 1 for holding additional linen.

The guides, preferably of the same material as the sideboard, are made as shown at *A*, Fig. 2. The upper guide on each side is placed 6 in. from the top of the compartment. If the partition between the compartment and the center drawer space is thin, the drawers should be removed and the brads driven through the partition from the side from which the drawers have been taken.

The construction of the new drawer or tray is shown at *B*. The front piece is rabbeted at the ends as at *C* to receive the sidepieces. The screws used are ¾-in.

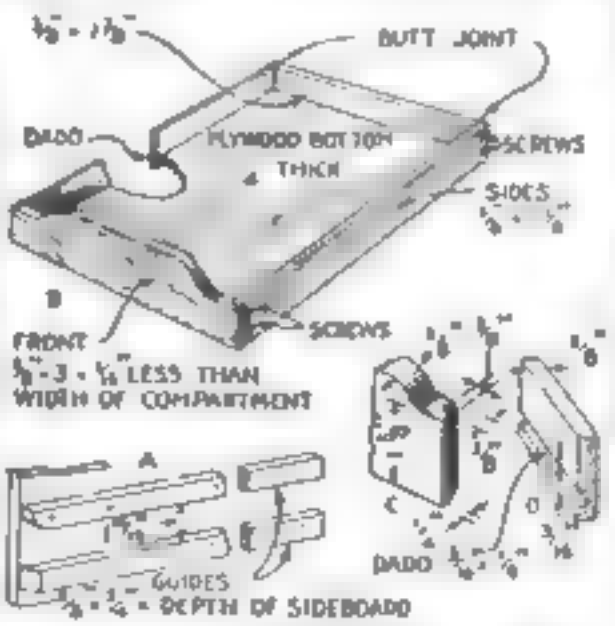


Fig. 2. How guides are placed on each side of the compartment and the tray itself is made

No. 6, flathead. A dado is cut in the sidepieces as shown at *D*, into this groove the ¼-in. plywood bottom is fitted.

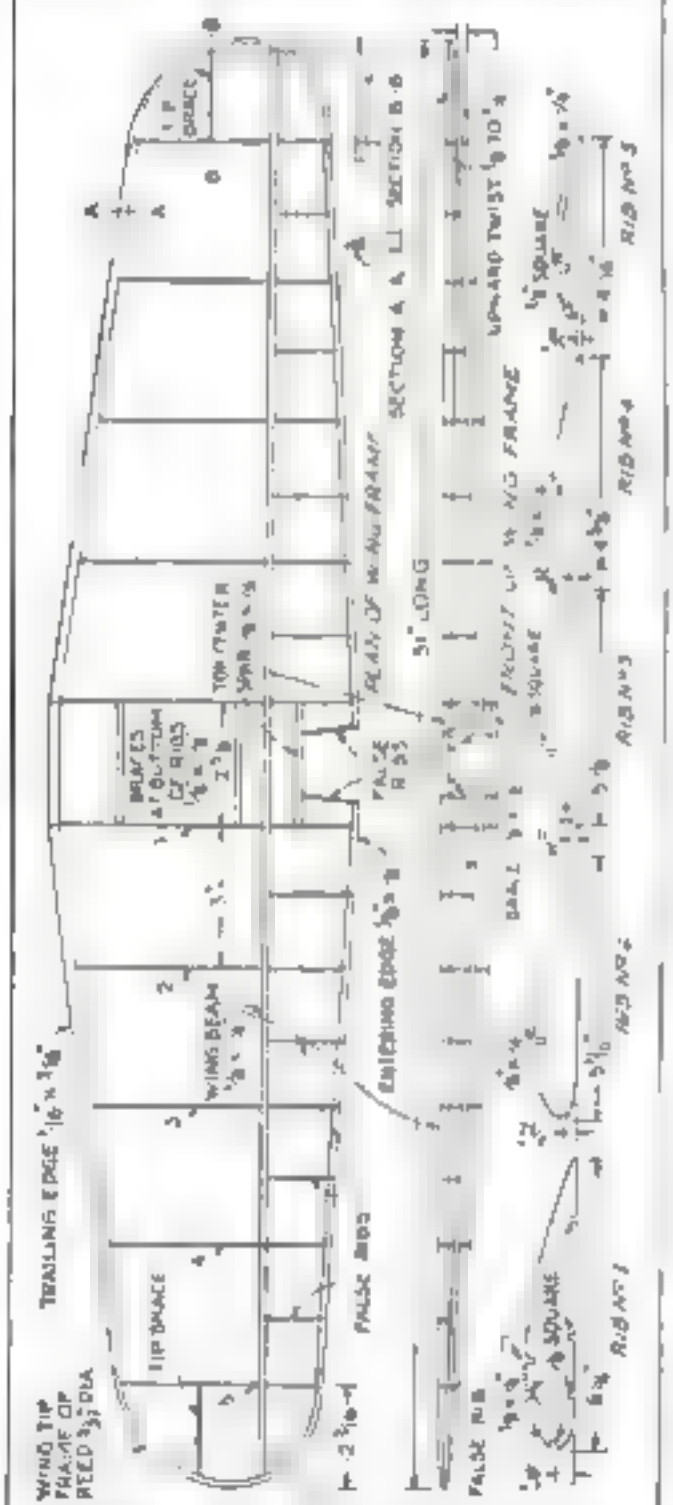
The drawer is finished like the rest of the sideboard. In the example illustrated in Fig. 1, it was given a coat of walnut wood stain followed by a coat of thin shellac. When dry, the shellac was sanded lightly with No. 00 sandpaper; then the surface was finished with two coats of wax.

Building the Wing for a Lockheed Model Plane

By Vincent Johnstone

IF YOU are building the flying scale model airplane described in the article "How to Build a Lockheed Model" published last month, your next step will be to construct the wing.

You will need the following materials. 3 pcs. balsa for wing ribs, 1/32 by 2 by 20 in.; 2 pcs. balsa for entering edge, 1/4 sq. by 20 in., 1 pc. balsa for wing beam, 1/8 by 3/4 by 31 in., 2 pcs. balsa for trailing edge 1/16 by 9/16 by 20 in., 2 ft. 3/32 in. diameter white German reed for wing tips; 2 pcs. of

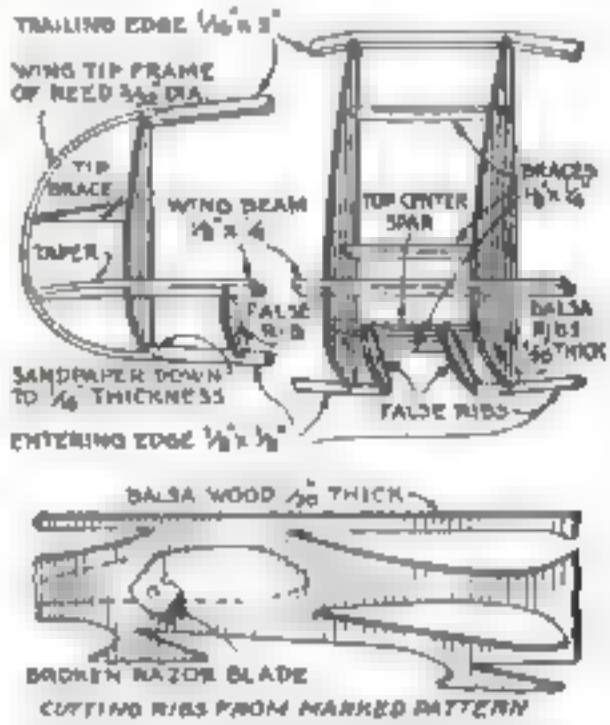


The wing framework. Lay out a full size plan and make templates for the various ribs.

superfine Japanese tissue 18 by 24 in. for covering the wing; one 2-oz. bottle of light dope.

It is advisable to lay out a full size plan of the wings and ribs. Using the actual size patterns of the ribs, cut out two of each size. Notch them very accurately for the wing beam and entering edges. A broken razor blade will be found handy for this work. Slip the ribs in place on the wing beam at their correct locations and fill around the joints with cement.

In order to counteract the torque of the propeller, the right wing tip must have a little more angle of attack to the air (known as angle of incidence) than the left wing tip, when viewed from the front. This is important. The trailing edge is sandpapered down to a triangular section with the knife edge to the rear. Install it on both sides of the wing by cementing



Details of the wing framework at tip and center, how the ribs are cut from balsa wood veneer, the grain, of course, running with the length.

it securely to the rear tips of the ribs. Very slightly round one half of the 1/8 in sq. balsa entering edges. The entering and trailing edges should end at the outer rib.

Bend two wing tips from the 1/32 in. diameter reed. Leave the ends about 3/8 in. longer than necessary. Cut them at a slight angle for a lap joint and attach them to the wing tip with cement. The beam will have to be tapered equally from the top and bottom to make a support for the wing tip. In addition, the wing tip should also be supported by the rib-like piece of balsa extending out from the end rib.

Install three 1/8 in sq. braces in the bottom of the wing, just between the two center ribs for attaching the wing to the body. The wing in this condition should weigh somewhat less than 1/2 oz.

The appearance and efficiency of the wing can be improved by installing a short false rib between each of the full wing ribs, as shown. These false ribs prevent wrinkles from forming in the covering, and help to hold the wing curve to its proper shape for aerodynamic efficiency.

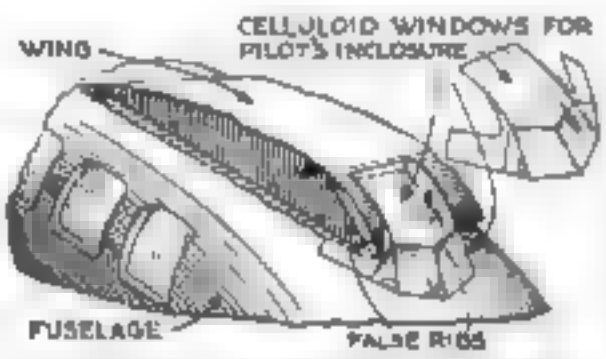
Now cover all the wing, except the bottom between the two center ribs and the top between the same ribs from the entering edge to the main wing beam. The top of the wing should be covered

between the two center ribs from the wing beam to the rear edge.

Apply a light dope and hold the wing with a slight twist by depressing the left entering edge and raising the right entering edge when viewed from the front. When the light dope dries, there should be an incidence in the right wing tip, when viewed from the front, of from 3/16 to 1/4 in. This will depend upon the amount of rubber used to fly your model

Attach the wing to the body by securely cementing the square crosspieces on the bottom—those between the two center ribs—to the flattened portion of the hollow balsa fuselage.

Make two extra false ribs to the pattern of the front part of the largest rib, as illustrated. Use these as a starting point and build around them a neat little pilot's inclosure, which can be covered with thin



Broken-away view of the wing on the fuselage, to show how the pilot's inclosure is constructed.

celluloid or a cellophane type candy wrapping. Cover the underside of the wing between the two center ribs and the body, as well as the small spaces between the two center ribs and the two false ribs for the pilot's inclosure. Dope them with light dope.

If you wish to make the model a realistic copy of the famous *Yankee Doodle* plane, which was blue and white, paint it as shown on page 123.

If you have made the fin and the elevator at the rear of the fuselage and the fuselage itself as light as instructed, you will find that the propeller, the dummy motor, the landing gear, and the heavier front part of the fuselage will cause the machine to balance at a point between the entering edge and the wing beam.

You are now ready to give your model a trial glide and flight. In flying trim with about eight strands of rubber for a trial, the model should glide rather steeply when unwound.

When launched gently at about the flying speed with its nose pointed slightly downward, the tail of the model may drop; then the machine stalls and falls quickly. In this case you will have to add a little weight to the nose or bend down the elevator slightly

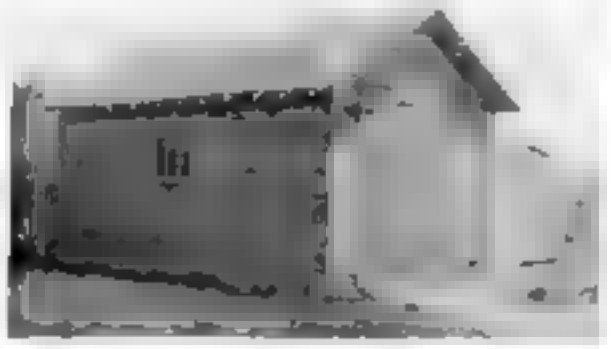
If in these trial glides the model noses over steeply without apparently recovering or stalling first and lands on its nose, repair any damage with a little cement and raise the rear edge of the elevator slightly. If the model dives to the left in a circle, the inner wing tip on the wing which is low in the glide should be warped up considerably and held in this position until set permanently.

Note: To make an inch scale for measuring dimensions on the body drawing (page 81, September issue), draw a line 2½ in. long and divide into ten equal parts.

Roll Roofing Transforms an Ugly Garage

IN ONE corner of a recently acquired suburban property was a shed that was spoken of as a garage. Its walls were of unpainted rough clapboarding, there was no trim around the windows and doors, and the lean-to tool shed was built of boards that had once formed a real estate sign.

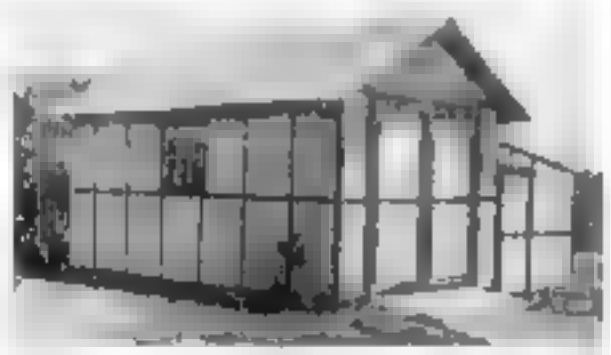
The new owner took immediate steps to make it more presentable. As he did not want to go to the expense of shingling



Although an eyesore, this hastily built garage was too useful to be torn down.

it, he solved the problem by covering it with roll roofing surfaced with crushed green slate. The roofing, cut into lengths reaching from ground to eaves, was nailed at the edges, and the joints were covered with strips of wood ¾ by 2 in. All bulging was prevented by placing horizontal strips in the centers of the panels.

Strips of the same size formed the trim around the doors and windows. It would



The same garage after being covered with roll roofing and trimmed with strips of wood.

have been a tedious and painstaking job to paint the strips after they were nailed on, and time and effort were saved by painting them beforehand—three coats on the edges, and two on the flat surfaces, which received a third when in place to protect the nailheads.

Aside from the preliminary painting of the strips, the work was done in one day. The cost of the materials was twenty dollars.—R. B. W.

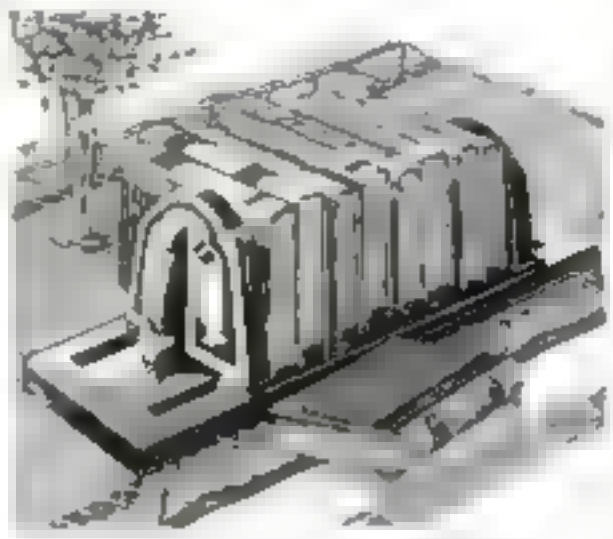
AT CERTAIN seasons of the year, moisture condenses on cement, stone, and brick floors and accumulates under any mats or rugs. A simple way to keep the mats from becoming moldy is to place sheets of waxed sandwich paper under them. These can be obtained almost anywhere, cost little, and are readily changed or removed.—A. E.

A new method of making decorative leather articles will be described by F. Clarke Hughes in the November issue.

These Book Ends Will Not Slip

ORDINARY book ends or blocks, no matter how heavy, are likely to spread apart when a number of volumes are placed between them. The book holder illustrated, however, will not slip, because of a locking effect obtained by means of two dovetailed slides.

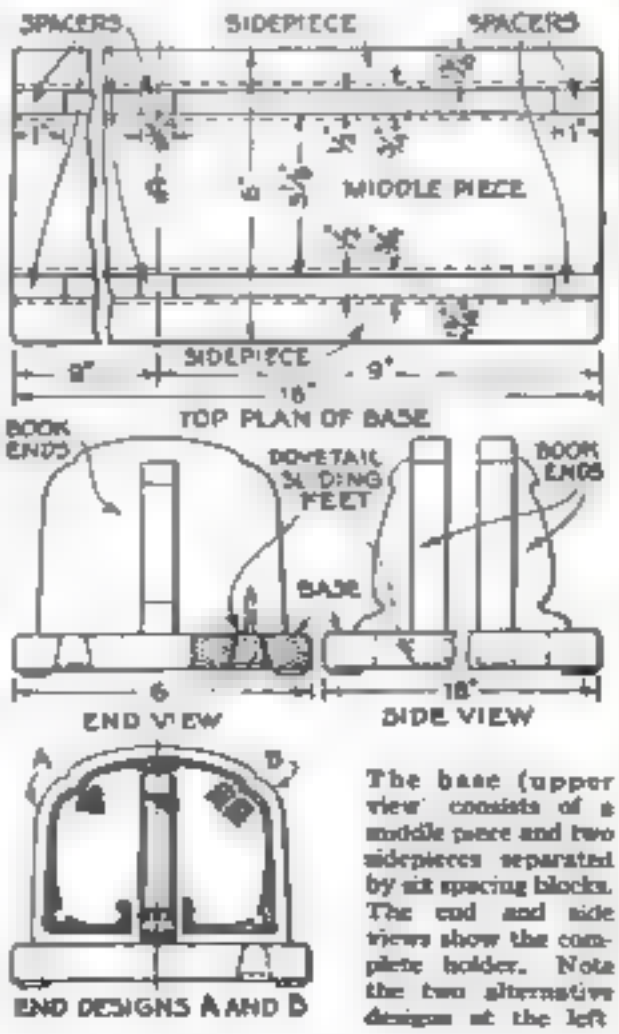
This ingenious method was used by G. A. Buck, of Roanoke, Va., in making a



The end supports have dovetail-shaped feet which lock automatically in the long grooves.

book holder of black walnut for a set of books which he desired to hold in perfect shape on his desk. As he is an expert craftsman, he followed a design which would be too difficult for the average amateur. The simplified design shown was prepared by William H Varnum Associate Professor of Applied Arts, University of Wisconsin, and it can either be left perfectly plain or ornamented with inlaid or colored designs such as those suggested below at *A* and *B*.

While it would appear to be difficult to make the dovetail slides, Mr Buck used a simple method, requiring only a hand



The base (upper view) consists of a middle piece and two sidepieces separated by six spacing blocks. The end and side views show the complete holder. Note the two alternative designs at the left

plane and an ordinary marking gage

First, he dressed a piece 3½ in. wide and 18 in. long for the middle part of the baseboard. Then he prepared a strip ¾ in. wide and 12 in. long and planed both edges of the strip to the same taper as the edges of the middle piece. This was cut into ten pieces, six of which were used as spacers between the middle section and the outside strips of the base, and four of which were later glued and screwed to the end pieces to form the dovetailed feet which slide back and forth in the grooves.

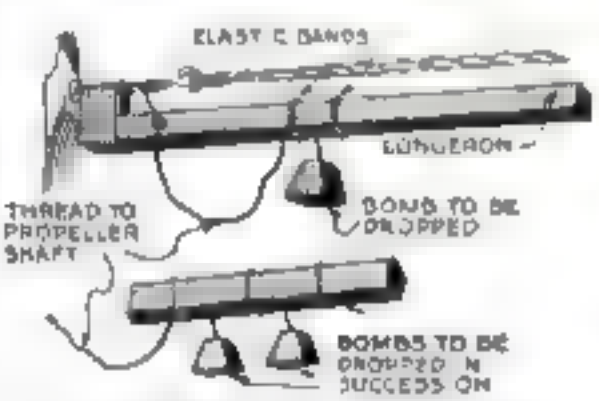
The middle piece and the six spacers were placed on a level surface with tissue paper underneath to prevent the glue from sticking to the bench, and were glued together. No nails were used

The outside strips next were prepared with a taper on one side only, these were fitted against the spacers and glued.

Before the four dovetailed feet were attached to the end pieces, a fraction was planed from them so that they would fit the grooves nicely. A small hole was drilled through each of the pieces for small screws. Then the ends were placed square with the edges of the base and the feet were inserted in the slots from the bottom, glued, and allowed to dry. Finally the screws were driven in flush.

Releasing Bombs from a Model Airplane

BOMBS and parachutes can be dropped from a model airplane by means of the simple releasing device illustrated. When the propeller shaft turns, it pulls

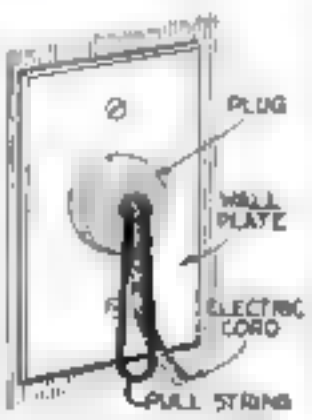


As the propeller shaft revolves, the thread is wound up and releases the bomb or bombs.

the thread through the rubber band and allows the bomb or parachute to drop. Several can be dropped in succession, if desired.—JAMES J. DOYLE, JR.

Pulling Electric Plugs

TO DISCONNECT an electric appliance by grasping the cord near the point where it is connected to the plug will soon loosen the connections. It is better to fasten a loop of strong string, such as chalk line, to the plug on the inside.—W. L. HUNTER.

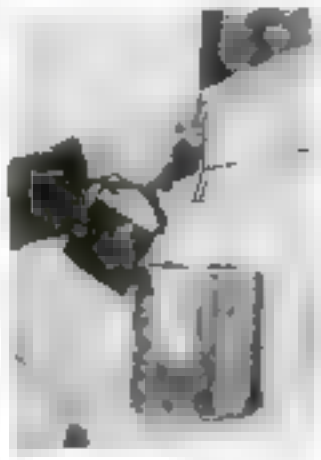


The loop is pulled instead of the cord.

TIGHT unions, ells, tees, and the like may be loosened by heating them with a blowtorch and applying kerosene or lard oil to the threads.

Finger Grip Improves Paint-Pot Hook

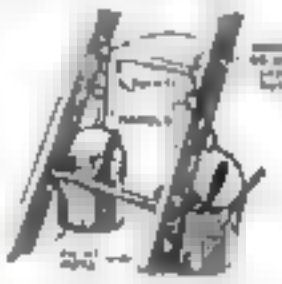
IF YOU make two paint-pot hooks of the type illustrated, you can ascend a ladder with two buckets of paint and two or three brushes and still place the hooks without difficulty over a rung wherever you desire.



Suspending the pot from a window sill.

To use the hook, place your fingers in the ring made for that purpose, drop the paint pot between the rungs, and catch the hook on the rung above. If you prefer, you can even hook the wire over the rung with the paint pot hanging on the outside of the ladder.

In making one of the hooks, squeeze the crook together so that it will snap over the bail of the paint pot; then it will not easily become unhooked. File the other end slanting with a long beveled point on the near side, so that the hook can be set on top of a porch railing, or even on a slanting window sill, without its slipping.—LOVAL R. JONES.

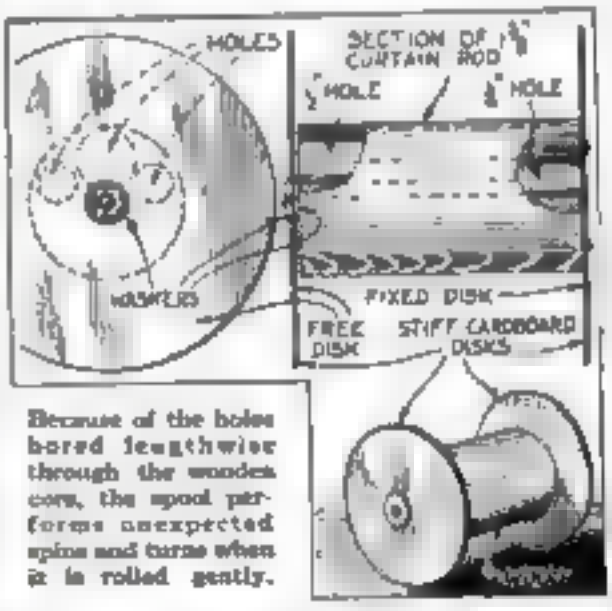


Two ways in which the pot can be hung.

Innocent Looking Spool Rolls Erratically

WHEN given a slight push on a smooth table or floor, the trick spool illustrated will perform unexpected spins and turns, but if rolled hard, it will go in a relatively straight line.

To make the toy, a section of curtain pole about 1⅜ in. in diameter and 2½ in. long and two stiff cardboard disks about 3 in. in diameter are required. The wooden core is prepared by drilling one ½ in. and two ¼ in. holes through it lengthwise in the locations shown. One disk is tacked permanently to one end of the core, while the other is attached so that it will turn freely, with a washer on each side.—DONALD W. CLARK.



Because of the holes bored lengthwise through the wooden core, the spool performs unexpected spins and turns when it is rolled gently.

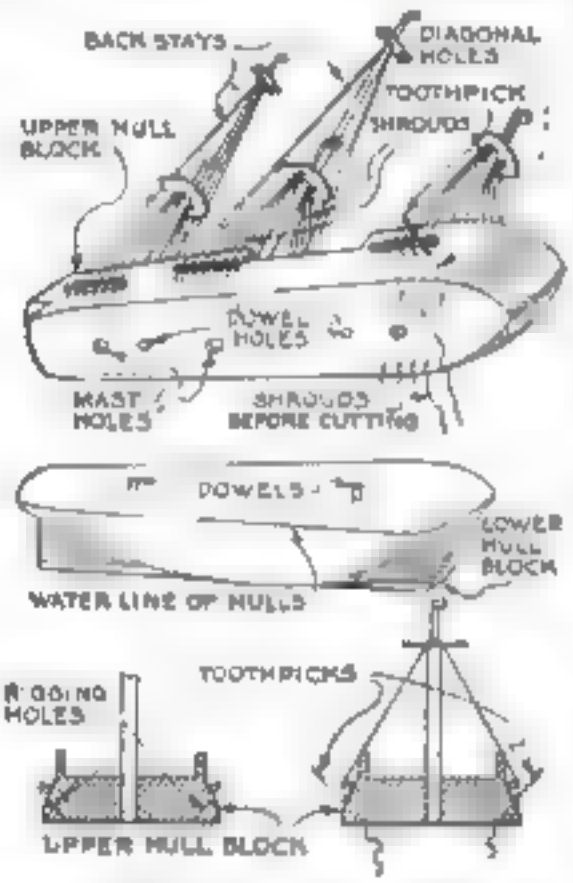
Simple Way to Make Small Ship Models

By Lieut A. R. McCracken, U. S. N

SMALL and medium sized ship models may be simplified by making the hull in two parts. The work is more convenient to handle and the rigging is made taut without tying knots in inaccessible places.

In making a 10-in. model of the *Constitution*, two pieces of wood were selected for the hull, each large enough to take the deck plan of the model. One was a little thicker than the depth of the hull above the water line and the other a little thicker than the depth below the water line. Dowels were inserted tightly enough to hold the blocks firmly together yet allow them to be pulled apart later.

The hull was carved and sandpapered in the usual way, the blocks pulled apart, and the dowels removed. Deck fittings and other details were built up, holes for



Small model divided along the water line to lessen the work of painting and rigging it.

masts drilled completely through the upper block, and the two halves of the hull painted separately, making a clean-cut water line.

At the points in the sides of the upper half of the hull where the shrouds and backstays would be normally attached, holes of a size a little larger than the thread to be used for the rigging were drilled diagonally into the block and out through the bottom. When the masts were stepped, the standing rigging was run right through the holes and left with long ends. A little quick drying cement was rubbed on the tips of the threads to make them stiff enough to be pushed through without using a needle. The threads were drawn taut from the underside in pairs, one from each side of the ship, and held with toothpicks dipped in cement and then broken off flush.

After the model had been finished, the two halves were redoweled and cemented.

How I Motorized My Home Workshop

By G. R. W. Roberts

FOR a home workshop where only one machine is in use at a time, I have found after considerable experimenting with other arrangements that the one illustrated in Fig. 1 is practical and economical. When I want to use any particular machine, I simply put on the belt for it and leave off all the other belts. Then I use the nearest switch to start and stop the motor.

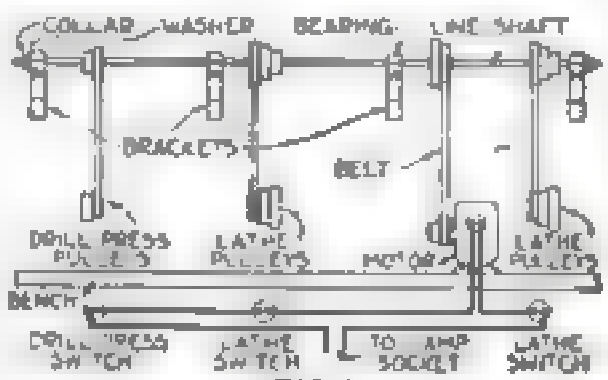


FIG. 1

General arrangement of the motorized workbench with motor, line shaft, and switches.

The machines—two lathes, a drill press, and a grinder—are arranged on the 2 by 10 in. by 12 ft. plank that forms the front of my bench. The line shaft, consisting of 10 ft. of ¾-in. cold-rolled steel, is mounted by means of four homemade bearings on the wall over the bench.

A two-speed pulley on the motor and another on the line shaft give a choice of 500 and 650 revolutions a minute. At the proper locations on the line shaft I placed some cone pulleys to correspond with those on the machines.

For bearings I use the method of construction illustrated in Fig. 2. Two oak blocks 1 by 1½ by 3 in. are bolted together and bored to receive a piece of brass pipe or a brass bushing. To keep the bushing from turning, I solder on a small piece of brass, which fits into a recess in the lower block. A hole is

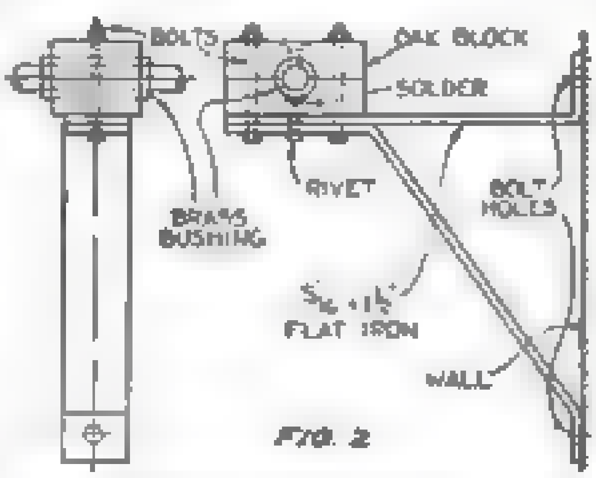


FIG. 2

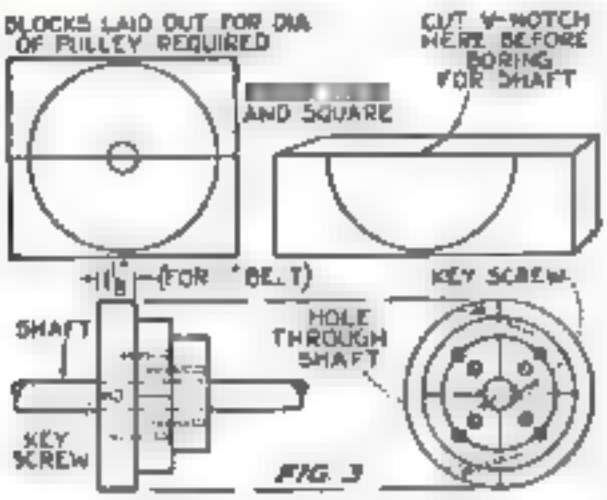
Front and end views of one of the homemade shaft bearings. The shaft is ¾ in. in diameter.

drilled for oiling the shaft, and the blocks are bolted to flat iron brackets.

All the belts are 1-in. single-ply leather, which I cut to the correct length and take back to the belt supply dealer to have him fasten the ends with a special machine.

To make each of the line-shaft pulleys, I use two pieces of 1½-in. thick wood, as

in Fig. 3. Two of the edges are fitted together, and the center and the diameter of the pulley are marked. In the joining edge of each piece at the center, two V-cuts are made with a saw so that



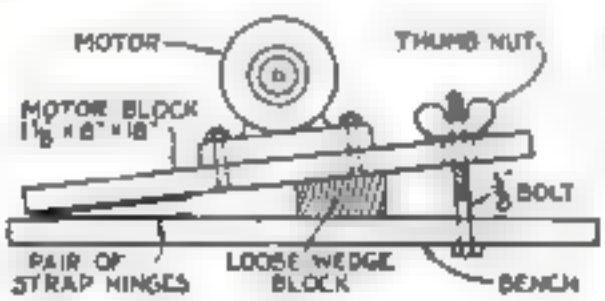
Method of laying out and preparing the step pulleys and fastening the parts to the shaft.

when the pieces are clamped together the notches will form a guide for the point of the bit used to bore the holes for the shaft. This hole is bored to the exact size of the shaft, and the pulley is then cut.

A ¾ in. hole is drilled through the shaft at the desired location, and one half of the pulley is fastened with a No. 14 screw, which holds it securely to the shaft. The other half is then fastened at the edge by using glue and screws driven at an angle as shown. Then the remaining steps are assembled, with the grain of each crossing that of the one before.

If care is taken in laying out and cutting the individual blocks, the complete cone pulley will run fairly true. To finish it off I make a temporary tool rest and turn it with a chisel right on the line shaft, giving each step a little crown so that the flat belt will run in the center

To keep an even tension on the motor belt, the motor is mounted on a separate block (Fig. 4), which is hinged at one end and has an adjusting screw at the other



The motor is mounted on a hinged block so that the belt can be tightened quickly and easily.

Simple Tension Regulator

WHEN the home experimenter needs a simple device for regulating the tension of light springs or similar purposes, he can make one quickly and cheaply from the adjusting nut and stem of a pair of ordinary school compasses as shown. It can be mounted by means of a staple or a bent nail.—F B.

Spring tightener made from a cheap compass.

How to Turn a Pair of Candlesticks from Steel

By J. W. BOLLINGER

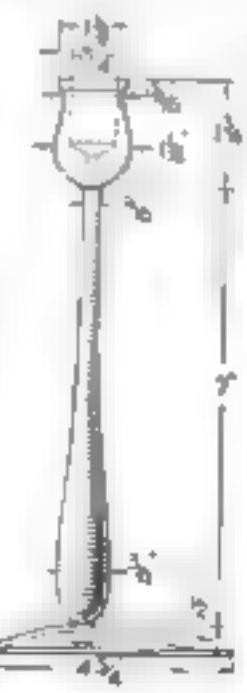
The candlesticks at the right afford a [illegible] Care [illegible] be accurate especially

AMATEUR craftsmen who enjoy lathe work will find these metal candlesticks a satisfactory problem on which to try their skill

A piece of 1¼ in cold rolled steel about 5 in long will make two cups. Face off the ends, bore a ¾-in. hole 1 in. deep into each, and drill the rest of the way through the piece with a ⅝-in. drill. Thread this hole for at least ¾ in. with a ½ in.-20 U.S.S. tap.

Make a full size drawing of the cup on paper With the cutting-off tool set 1¼ in. from the end of the stock, cut in about ¼ in. deep to start. Move the cutting-off tool farther along the stock and cut into it enough to bring the metal down almost to the finished size at that point. Take several such cuts.

Reverse the stock and take the same cuts on the other end. Remove the waste stock by using both longitudinal and cross-feed levers at the same time.



Shape and dimensions of the candlesticks; they are made in three parts, cup, stem, and base

File one of the cups and polish it with No. 00 emery cloth and No 00 sandpaper. Cut it all the way off

Caliper the polished cup and the one

How the disk of metal for the base is "dished" or "raised" with one powerful hammer blow.

still to be polished and keep working until both are as nearly alike as possible.

Cut two pieces of ¼-in. cold-rolled steel 9 in. long, and center-drill each end. Move the tailstock center over 1/16 in., and mount a piece between centers. After making a drawing of the upright on paper, cut the metal almost to shape, work it down, and polish it carefully. Make the other piece as nearly like the first as possible.

Line up the tailstock center and turn the upper ends of the upright down to ⅝ in. in diameter. Thread these ends with a ¾ in.-20 U S.S. die. Cut away a small part of the threads on the uprights near the shoulder so that it will be possible to draw the cups and the uprights snugly together

Cut the base end of the uprights to ⅝ in. in diameter and thread with a ⅜ in.-16 U S.S. die.

Get two pieces of No. 16 sheet iron, which is about 1/16 in. thick, for the bases, or even a little heavier stock will do. You can cut it down on the lathe if you wish.

To make the bulge in the center of each base, or "raise" it, as it is called,

Checking the straightness of an assembled candlestick—a certain test of the workmanship.

get a pipe collar or ring about 3 in. in diameter, lay the stock on this ring, and place over the center of the disk the piece of scrap cold-rolled steel that was left after you made the two cups. Strike the scrap metal a blow with a heavy sledge. One good blow ought to do the trick.

Hammer down the edge of the iron until the base rests flat, lay it back over the ring again and hammer the bulge until it is the same all around.

Mount the base in a chuck and drill a ¾-in. hole in the center. Face off a small portion of the metal around this hole for the upright to rest on. Polish the pieces for the base as you did the cups and the uprights.

Screw the cups onto the uprights and fasten the bases to the uprights with ¾-in. nuts. Test with a square.

If you want to make the bases heavier, turn the candlesticks upside down and pour in Babbitt metal, but first file the sides of the nut off at an angle so that the babbitt will be held in place as if by a dovetail.

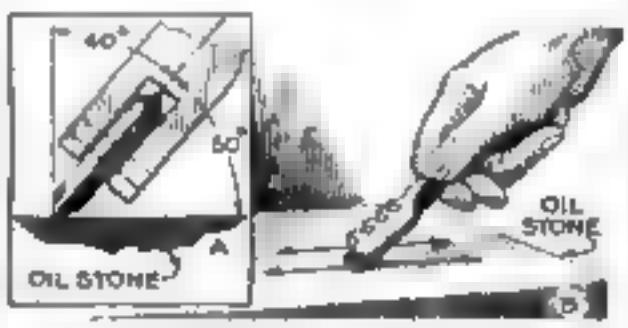
Have the candlesticks silver plated at a commercial plating works, or merely polish them, dry them thoroughly in front of a fire to remove all moisture, and give them a coat of transparent lacquer. If you prefer, you can mix up some "antique copper" bronzing mixture and make them look like old copper candlesticks. Finish the job by gluing felt from an old felt hat under the base.

When you buy the candles, take the candlesticks along and try several sizes and styles to see which look best.

Sharpening a Glass Cutter

MANY a glass cutter that has been thrown away because the wheel failed to give satisfactory service might have been used many more times if resharpened on a fine oilstone.

To sharpen a wheel, hold the cutter as if to cut glass but with the wheel inclined on the oilstone as shown at *A* and *B*.



How the glass cutter is held at an angle and rubbed on the oilstone in the sharpening process.

The angle of the handle to the stone will be about 40° off the perpendicular, while the face of the wheel will be at an angle of 30° to the side of the stone. With the cutter in this position, work the wheel back and forth in the direction of the arrows. If held properly, the wheel will turn, but it will be ground sufficiently to restore its keen cutting qualities. Reverse the cutter to sharpen the opposite bevel.—C. ANTHONY VAN KAMMEN.

TO MAKE a keen cutting edge on plane bits, chisels, and other sharp-edged tools, try using a piece of cork linoleum as a strop. After sharpening the tool on an oilstone, stroke it on the burlap side of the linoleum.—AUGUST MILLER.

New Horn Improves Old Phonograph

By Walter E. Burton

OLD phonographs, which the newer music boxes make a little out of date, can be given a better voice by substituting an exponential or air-column horn for the old one and by adding an improved reproducer and tone arm. This type of horn can be obtained from almost any large radiosupply house. Its size will be regulated by the space available in the phonograph cabinet, but obtain one with as long a tone-travel space as possible so that the low tones will be reproduced well.

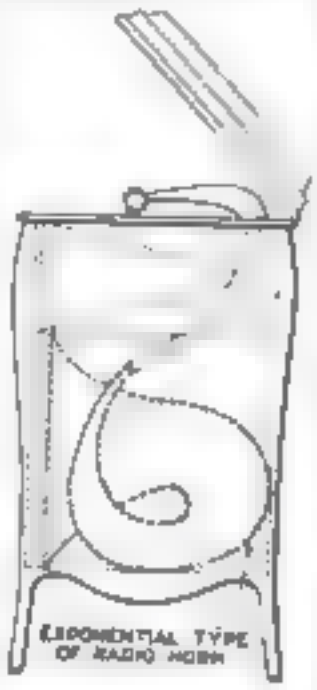


Diagram showing horn in phonograph cabinet

In a cabinet type phonograph the horn may be placed in the compartment formerly occupied by the old horn or in the record compartment, the latter being larger and better.

After the space in the cabinet has been cleared, the horn is inserted and padded around the edges with felt or other material. A section of metal, rubber, or fiber tubing, large enough to slip over the small end of the horn, serves to connect the tone chamber with the reproducer arm. The connection should be as air-tight as possible.


How to set up a horn experimentally to test for yourself the difference in tone quality.

Provided you can obtain the use of a suitable horn, you can test the desirability of the change by connecting the reproducer and horn temporarily with a vacuum cleaner hose as illustrated

Two Pipes Aid in Bending Heavy Reinforcing Bars

Using two pipes to make so-called "hairpin" bends in iron bars for reinforced concrete work.

CONCRETE workers are frequently called upon to bend reinforcing bars and heavy bar iron without heating, often with no adequate facilities. A simple way to bend them is to use two pieces of iron pipe, preferably about 4 ft. long.

The bar is passed through the two pipes, one of which is held down with a foot while the other is pulled up and, if desired, bent back to make what is known as a "hairpin" bend. On extra heavy rods two men can work together; one holds down while the other makes the bend. There is no tendency for the rods to kink in the wrong place.—H. L. WHEELER

Small Worm Wheel Cut with Ordinary Tap

WHEN the writer was confronted with the problem of making a small worm and gear for light service, he used a method that simplified the work very much. In place of first cutting gashes in the worm-wheel blank, he cut the teeth from the solid, and used a tap for a hob.

A piece of flat steel was tapped for a ¾-in. cap screw, about which the worm

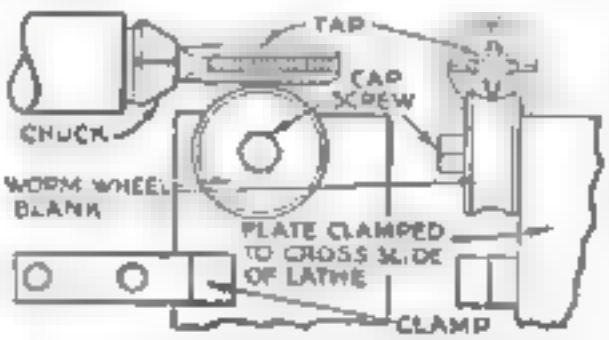


Diagram showing how the worm wheel blank is mounted for cutting the teeth with a tap.

wheel revolved. The piece of steel was clamped on the cross slide of a small lathe at the right height in relation to the spindle, and the tap was held in the chuck.

When the lathe had been started, the wheel was fed very slowly into the tap, which cut the teeth without stripping.

What made this result possible was the careful sizing of the blank. It had been turned so that its circumference was exactly the product of the pitch by the number of teeth. The worm to mesh with the wheel was threaded as an ordinary screw.—CHARLES KUGLER.

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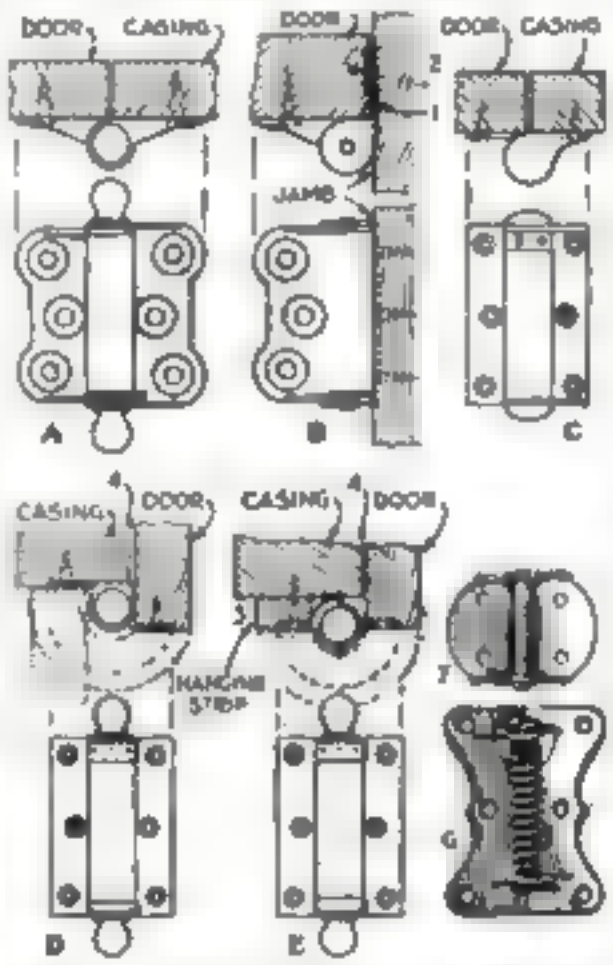
Hints on Applying Spring Hinges

PROBABLY the most familiar form of spring hinge is the screen door type shown at *A*, which is applied simply by holding the door in place with wedges and driving the screws.

The flange type *B* is another form of *A*, it may be used in places where the door is to be hung between the jambs of an opening. The flange may be set in a jamb as at *1*, or it may be placed directly upon the face of the jamb, in which case the thickness of the flange may be cut from the door, as at *2*, and the face member of the



Seven types of spring hinges, and sectional views showing how five of them are attached.

hinge moved over enough to allow the door stile to fit the jamb.

The surface type at *C* may be used upon any door or screen stile not less than 1 in. in width. The strength of its spring may be changed by adjustment. Hinges *D* and *E* also are adjustable and may be bought in sizes ranging from 3 to 8 in. long. The flanges of *D* are to be fitted into the door jamb and the edge of the door, much the same as an ordinary hinge; in the case of *E*, a hanging strip *3*, to coincide with the thickness of the door, should be fastened in place. The placing of the flange of *D* and the hanging strip of *E* will demand care, for the door should swing back against the wall as at *4*.

Hinges *F* and *G* may be purchased in smaller sizes and at a lower price; they are for light work.—DAVID WEBSTER.

WHEN it becomes necessary in hanging or repairing doors to shim out a hinge with cardboard, slightly crease the shim with a knife and then fold it on the cut. The folded cardboard will spring apart when inserted behind the hinge and will therefore stay without falling out, unlike a flat piece which is likely to cause annoyance by dropping before the screws can be tightened.—AUGUST MUELLER.

Testing Defective Electric Cords

Paste this Home Workshop Reference Sheet, including the head above, in your scrapbook in the section marked *electricity*. (October, 1929, POPULAR SCIENCE MONTHLY.)

How can I find what is wrong with the cord of an electric lamp or appliance?

THE answer to this question must be divided into two parts, with reference to the additional questions: Does a fuse blow out when the cord is connected to

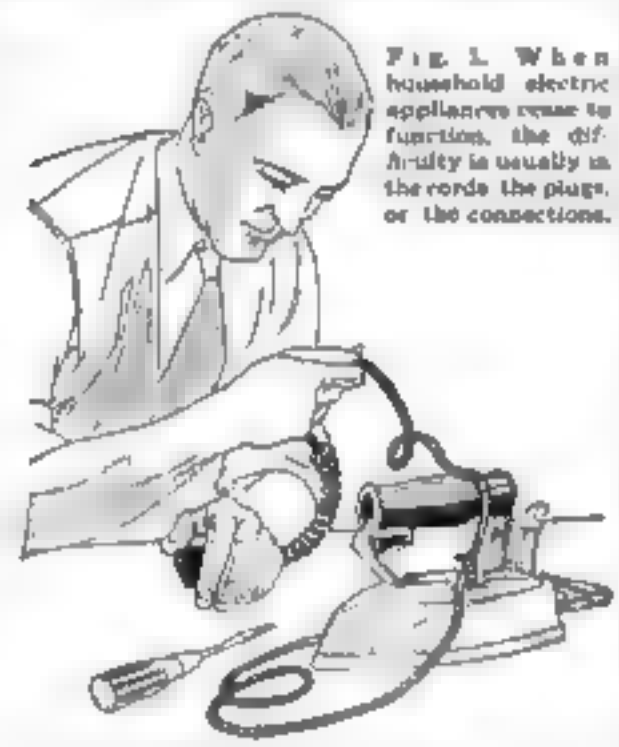


FIG. 1. When household electric appliances cease to function, the difficulty is usually in the cords the plugs, or the connections.

the circuit? Does the fuse remain intact, but the appliance fail to function?

The blowing of the fuse denotes a short circuit, either in the connections at the end of the cord or perhaps in the lamp or appliance itself.

If the fuse does not blow when the connection is made, yet the lamp or appliance will not operate, the chances are that there is an open circuit somewhere in the cord in the connections at the ends, or possibly in the lamp or appliance. An open circuit is a condition where the path for the current has been opened or interrupted.

What are the tests for locating a short circuit?

PROCEED first to the most common cause—the attachment plug on the end of the cord. Here lies probably seventy-five percent of all cord troubles. Examine carefully the wires leading to the contact screws. Is the insulation in good shape right up to each screw head? Are there any stray strands of copper wires that reach over to the other point or screw? If a knot is tied in the wires, un-

tie it and see that the insulation is good within the folds of the knot.

Next run your fingers along the entire length of the cord, feeling for worn places, perhaps poorly repaired with tape (Fig. 1). Follow the cord up to the point where it enters the lamp or appliance. Is there a smooth bushing protecting the thin insulation (outer covering) of the cord, or is there a rough-edged hole and does the cord look frayed and questionable at that

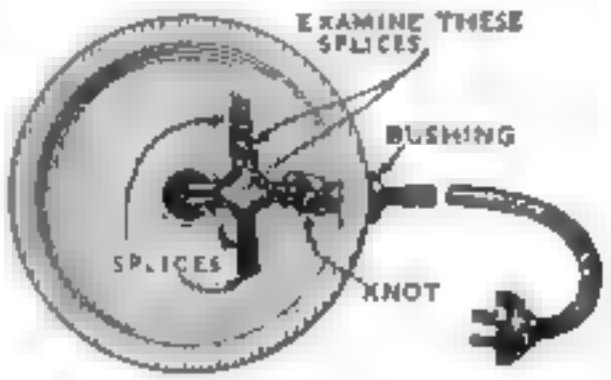


Fig. 2. In testing a table or floor lamp, turn it up and inspect the cord, knot, and splices.

point, with perhaps a glimpse of the copper showing?

In the case of a lamp, turn it bottom side up and, if there are splices made in the base, see that they are well made and properly taped. Be sure that the tape turns over the end of the joint, protecting it well (Fig. 2).

If an appliance is in question, such as an iron, toaster, or vacuum cleaner, the method of connecting the cord to it must be inspected. Irons and similar devices generally use a composition attachment plug which is made in two halves, clamped together by two small bolts. This plug, which pushes on over two prongs in the base of the iron or toaster, is often at fault, and should be inspected. Loosen the screws that pass through the plug and open the two halves. You will find a spring contact piece attached to the end of each wire by a short screw. Look for burnt or damaged insulation, with possibly the two wires twisted tightly together; also inspect the cord for injury where it left the end of the strain spring. The wires in this type of plug usually lie in separate grooves molded in the composition for them. See that they are correctly placed there when you assemble the plug or the halves will not fit together again.

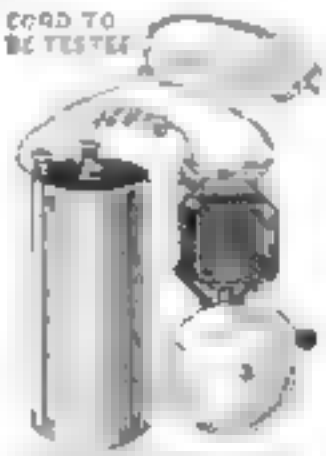


Fig. 3. Doorbell and battery for testing.

How to open circuit hunted?

IN MUCH the same way. Start at the plug on the end of the cord and look for a broken wire or loose connection under the screw. Next follow the cord its full length as before, feeling it for a "lump" spot, which may indicate a break.

These checks having been made without results, next test the cord in the fol-

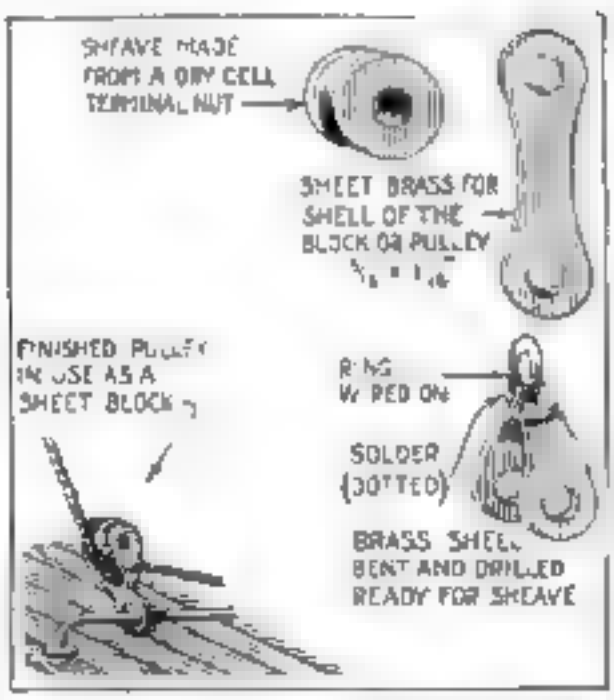
lowing manner. Obtain an ordinary electric door bell (borrow one from off the kitchen wall, if necessary) and a dry cell, and connect them together in series as illustrated in Fig. 3. Test the bell to be sure it rings. Now attach the two wire ends at one end of the cord as shown, one to the free post on the bell and the other to the free post on the battery. Touch together the ends at the other end of the cord.

If the cord is all right, the bell will ring. If it does not and you are sure that your tester is connected as described, keep the free ends at the farther end of the cord touching each other and bend the cord between the fingers very slowly along its length. If there is a break somewhere, it will probably come together by this treatment and the bell will ring.

When the break has been found, if it is quite near either end, the cord may be cut off there and reconnected, but if it is in the center somewhere, do not try to repair it unless for temporary purposes. A repaired cord is seldom satisfactory, in fact, it is prohibited by the electric inspectors in many cities as unsafe. The price of new cord is low and is a good investment in replacing worn or broken cords that might cause a serious fire at any time.—HAROLD P. STRAND.

How to Make Small Pulleys for Model Work

SMALL brass pulleys sometimes are needed for curtains, for yacht models, and for other uses. To make them, shape a piece of scrap brass as indicated. Drill a hole through one end, fold the piece end to end, and drill a matching hole through the other end. For the sheave use the terminal nut from an old electric dry cell after filing down the thicker side; mount it on a piece cut from a wire nail. Bend the ring from brass wire and attach it firmly with thinner wire. Solder the ring and the spindle in place, and the pulley is made. —J. G. PRATT.



Small homemade brass pulley for use on a yacht model, and its parts before being assembled.

Six Helpful Hints for the Home Mechanic

LIKE many of those who are motorizing their home workshops, I needed a pulley shaft to use with a ¼ H P motor. Finding that one would be somewhat expensive, I visited a garage junk pile and obtained parts for constructing an entirely satisfactory shaft, as shown in Figs. 1 and 2.

The shaft is the steering shaft from

Fig. 1. This countershaft for light work is merely a junked steering shaft from a small car and the bearings are old connecting rods.

any small automobile (I used a Chevrolet steering shaft). The bearings are connecting rods of either a Chevrolet or a Ford, or any kind of rods that have a bolt in the head (mine are from a Ford). If the shaft is to be very long, a third rod may be used in the center and fastened against the wall at right angles to the other two, as indicated in Fig. 2.

It will be noticed that the bolt in the top of the connecting rod extends partly into the hole. Far from hindering you

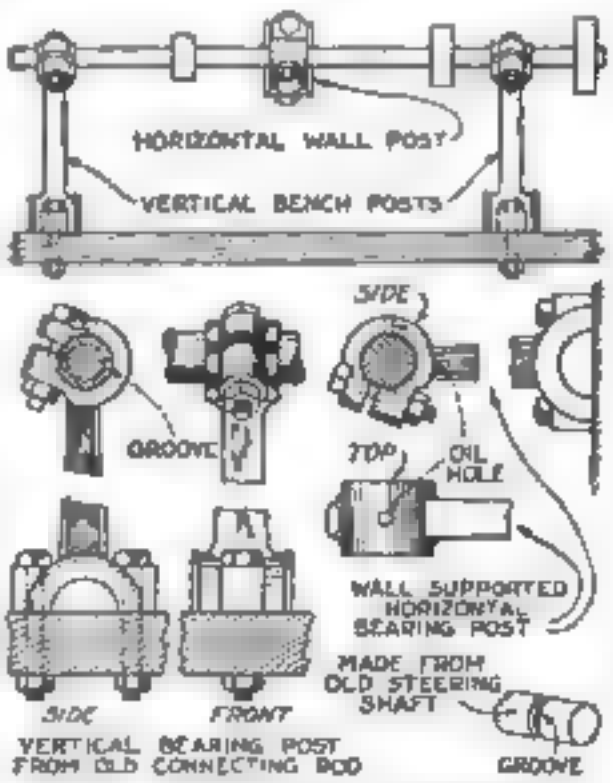


Fig. 2. The complete countershaft and details showing how the connecting rods are used.

from putting the shaft in, this will be a help. With a round file, make a groove all the way around the shaft at each end where you are going to place a connecting rod, and be sure to have it deep and wide enough. In the top of each bearing drill a ⅛ in. oil hole.

Now you are ready to mount the shaft. Put the bolts in and tighten them up until there is no play but still the shaft turns easily. Place the shaft on the bench or wherever you are going to mount it, and mark the locations of the bolt holes.

After you have the shaft permanently fastened, you may find that it does not run freely. Simply attach your motor to the shaft and start it running. In each of the oil holes place a small amount of valvegrinding compound or other abrasive and run it this way for about ten minutes. Then clean out the bearings with gasoline and place oil or grease in them.

The bearings will last indefinitely, as you can tighten them up when they become the least bit loose—a distinct advantage.—JAMES SUDDETH.

A METAL worker, inconvenienced by the loss of his acid brush while doing some soldering away from the shop, made

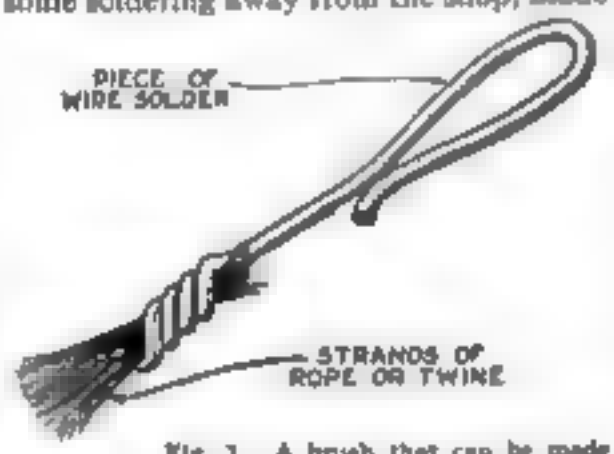


Fig. 3. A brush that can be made quickly for applying soldering acid.

a noncorroding brush in a few minutes from a short piece of wire solder and a few strands of rope or heavy twine, as shown in Fig. 3.—G. E. HENDRICKSON.

MADE for office work, the old-fashioned letterpress shown below is something that every amateur cabinetmaker would do well to have. Presses of this type often can be had for a song either from the original owners, who, of course, now have no use for them, or from junk dealers or even secondhand stores.

The one illustrated was purchased from the Post Office Department for 50

Fig. 4. For veneering and clamping small glued work, an old letterpress is excellent.

cents. Its capacity is 4½ by 16 by 20 in., and it is excellent for veneering or clamping up glued work. The upper or traveling part will tilt several degrees, thereby taking tapered work as well as flat. A patch may be clamped perfectly in any part of a board not wider than the press.

There are thousands of these presses lying around waiting to be put to work. In my small town there are two other larger ones of which I know and a dozen or more smaller copying presses.—R. C. STANLEY.

THE T-square illustrated in Fig. 5 has been found useful in making small sketches or drawings in the shop directly upon a sheet of paper attached to a pad. This permits making carbon copies.

The square blade was made from a piece of an old wooden ship curve ½6 in. thick, and the head from ¾ in.-thick

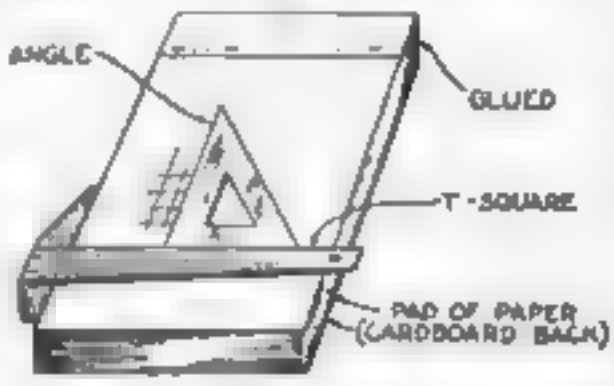


Fig. 5. A shop sketching outfit, consisting of a pad, a homemade T-square, and a triangle.

mahogany, but any close-grained woods will do.

A pair of small triangles, 6 in. for the 45-degree and 8 in. for the 30-60-degree complete the set.—W. E. PATRICK, JR.

INSTEAD of keeping miscellaneous screws, bolts, nails, and other hardware in a drawer or a box, from which

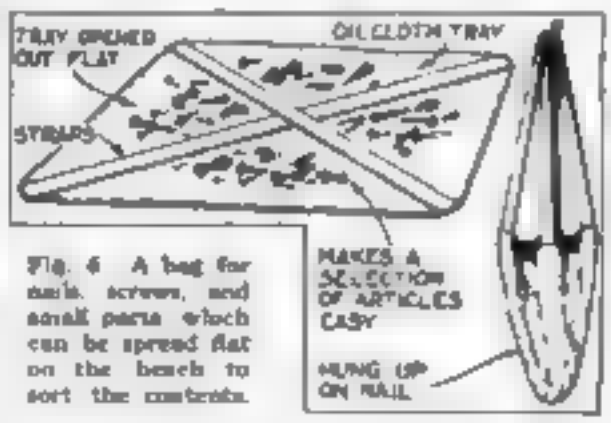


Fig. 6. A bag for nails, screws, and small parts which can be spread flat on the bench to sort the contents.

they have to be emptied upon the bench for sorting, one home mechanic uses oil-cloth containers made as shown in Fig. 6. Each of these consists of a square of oil-cloth provided with straps by which it can be hung on a nail or hook. Small articles may be dropped into them while they are suspended, and their entire contents can be sorted over by spreading them on the bench.—G. E. HENDRICKSON.

FOR locating broken connections within a radio set, inspecting the internal mechanism of models, and similar work, a tiny mirror on a long handle such as dentists use is a valuable tool. It will often save the work of disassembling intricate parts which interfere with direct vision.—J. B.

Glimpses of Unusual Men

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comparatively uneventful life of a lithographer, photo-engraver, and newspaper cartoonist. But then came the Spanish-American War, and he saw service in Cuba with his National Guard Regiment, meanwhile acting as war correspondent for the *Brooklyn Daily Eagle*. After his return he had settled down to the peaceful business of conducting a small newspaper syndicate when he learned that William Ziegler, millionaire manufacturer, was organizing an expedition to the North Pole under the leadership of Evelyn Briggs Baldwin, who had been one of Admiral Peary's assistants. The wanderlust seized Fiala and he joined the party as photographer.

The journey was unsuccessful so far as reaching the Pole was concerned, but it gave Fiala a chance to distinguish himself by his daring and ingenuity. The ship, the *America*, had been ice-locked for nine months when Baldwin decided to blast his way out. The crew got busy with explosives, but after a couple of days a few blackened dents in the ten-foot ice around the ship were the only evidences of their work. Then the photographer discovered an opening in the two-mile ice cake in which the ship lay embedded. He asked Baldwin for permission to blast the cake in his own way. Risking his life several times, Fiala mined the huge frozen island with gun-cotton for about a mile. Within five days, a series of terrific explosions had freed the *America*, and she returned home safely. In recognition of his feat, Baldwin made his photographer second in command.

WHEN two years later, in 1903, Ziegler sent out another North Pole expedition he placed Fiala in charge. The expedition sailed in June, again aboard the *America*. More than a year passed, and nothing was heard from the explorers. In July, 1904, Ziegler sent out a relief ship, but the vessel returned in the fall without news of the expedition. Another year went by without a word from Fiala and his men, and it seemed as if the Arctic had swallowed the *America* and all aboard her. Then a second rescue ship found Fiala and his crew encamped on two frozen islands north of Franz Josef Land.

They had suffered almost indescribable hardship. Settled for their first Arctic winter on Rudolf Island after battling forty-nine days through 500 miles of ice, they woke up one pitch-dark morning to find that their ship had broken away from its moorings in a Polar hurricane. After four days of icy tempest, the *America* came riding back, and Fiala left the base and transferred his headquarters to the ship. But not for long. One night, all hands were awakened by a thunderous crash and the shriek of breaking timbers. By the glare of rockets the explorers saw giant masses of ice crowding in on their vessel. They unloaded the ship in a frenzied rush. No sooner were they back at the base than the *America* was literally splintered to bits by the ice.

But Fiala did not give up hope of reaching the Pole. Two unsuccessful northward dashes followed. On the first, many of the men became so discouraged that their leader took them back to Cape Flora, on the southern tip of Franz Josef Land, where they could wait for a relief ship. The majority of his crew safely settled in huts, Fiala, with a handful of volunteers, started back north. With their dog teams and sledges, they made a fifty-four-day trip across frozen Polar seas, the last half through Arctic night. During this journey, Fiala and one of his men fell into the fissure of a glacier and were rescued by their companions. At last they reached Rudolf Island, their original base. In the spring, all was in readiness for the final dash to the Pole when, one night, the ice began to crack right under their tents. Fiala then aban-

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Glimpses of Unusual Men

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doned the attempt and started south, where the rescue ship found him and his men.

Back in New York, Fiala conceived the idea of making a specialty of outfitting explorers. One day, Theodore Roosevelt called upon him for equipment. Impressed by his personality and experience, the Colonel invited Fiala to accompany him to Brazil. Shortly after his return from this expedition, Fiala saw service on the Mexican border as captain of a machine gun troop. During the World War, he was placed in charge of the Army proving grounds at Springfield, Mass., with the rank of major.

Major Fiala, who is a member of the Explorers' Club, is an inventor and a writer as well as an explorer. Among the devices he has originated are firearms, a sleeping bag, tents, and a pneumatic attachment for canoes that prevents them from capsizing. He is the author of *Fighting the Polar Ice*, a description of the Ziegler expedition, the scientific record of the trip; and of a book dealing with the Spanish-American War.

A Patron of Sciences

THE latest contribution to science by Colonel E. H. R. Green, son of the late Hetty Green, the world's richest woman, is a $30,000 dirigible hangar on Round Hills, his 2,7-acre estate overlooking Buzzard's Bay at South Dartmouth, Mass. The building, 140 feet long and seventy-two feet high, has been placed at the disposal of research men of the Massachusetts Institute of Technology as a laboratory for conducting fog fighting experiments on the estate. It houses the *Mayflower*, a blimp presented to M. I. T. by Paul W. Litchfield, president of the Institute's Alumni Association and of the Goodyear-Zeppelin Company. It will enable investigators to explore fog regions a mile in the air at a slow rate of speed. Photographs of the blimp are shown on page fifty-two of this issue.

The fog laboratory is only part of a huge aviation experimental center the Colonel began establishing at Round Hills in 1927. His interest in flying dates from Lindbergh's transatlantic flight. The young airman's phenomenal accomplishment fairly elated the multimillionaire, who presented to his numerous friends solid gold replicas of the *Spirit of St. Louis* in the form of pins. He constructed a great airport, equipped with the two largest runways in New England, and erected a wall in Buzzard's Bay to act as a breakwater for seaplanes. The entire center cost more than $2,000,000. Next year the Colonel says he will turn it over to the United States War Department for one dollar.

But aviation, though his most recent hobby, is by no means the Colonel's only one. For years the latest developments in science and invention have fascinated him. Round Hills is a veritable scientist's paradise. Here in a group of completely equipped laboratories, at least a hundred men are conducting technical experiments in radio, radio movies, electric photography, and other branches of applied science.

One of the most remarkable features at Round Hills is a private radio station WMAF which Green built in 1923 at an expense of $500,000. Programs are carried by wire from New York to the estate, where they are amplified and broadcast through enormous loudspeakers that can be heard for miles. Hundreds of persons journey for miles in boats, motor cars, and on foot to enjoy them. But that was not enough for the altruistic Colonel. He remembered those who were unable to reach Round Hills. In the summer months, a receiving set is mounted upon a truck which visits hospitals, homes for the aged, orphanages, and

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Glimpses of Unusual Men

(Continued from page 148)

other institutions. For his own amusement, Green has a small loop receiver attached to the roof of the electric brougham he has used ever since rheumatism made walking difficult.

The Colonel enjoys an international reputation as an amateur photographer, and one of his laboratories is devoted exclusively to photographic experiments. Among his personal feats in this field is the photographing of scenes ten miles away with a forty-eight-inch focus camera.

Colonel Green, a man of unusual vitality and energy began his scientific hobbies about 1918, two years after the death of his famous mother. He was then just fifty years old, an age at which most men, inheriting vast wealth, would be content to take life easy.

But Green had had a hard schooling. His mother had determined that her son should get acquainted with work at first hand. After his graduation from Fordham University, New York, where he studied law, she obtained a job for him in a law office, where he was trained in the legal technicalities of real estate. Two years later she took him to Chicago, where she controlled great holdings, and personally drilled him in the management of property.

Three years later, in 1893, Hetty Green gave her son the Texas and Midland Railroad and sent him to the Southwest to manage it in person. Here Green demonstrated that he had inherited his mother's business genius. In the seventeen years of his management, the railroad increased in value from $750,000 to $5,000,000. Besides, he engaged successfully in a number of other enterprises and also entered politics. The title of Colonel was bestowed upon him by a Texas governor.

Even in the Texas years, Green's scientific leanings found an occasional outlet. Shortly after Marconi's wireless experiments in 1896, Green attempted to apply the new science to railroading, but was unsuccessful. He assisted Lubin, pioneer motion picture producer, who was one of his employees, in his early experiments, and once financed five French flyers who came to grief in Texas. In 1910, the Colonel was summoned back to New York to aid his mother, whose health was failing, in the management of her properties. He was married in 1917. One hobby he and Mrs. Green have in common is the education of orphan girls.

Small Balloons Show Height of Clouds

TOY balloons are being purchased in quantity by the United States Department of Commerce to measure the height of clouds above airports. "Ceiling" information is important to incoming airmen because low hanging clouds, besides having powerful updrafts rising beneath them, restrict visibility, making landings hazardous. When the balloons are inflated with hydrogen until they will support forty grams, about an ounce and a half, it has been found that they rise at the steady rate of five and a half feet a second. The balloons are timed as they soar upward. The number of seconds that elapse before they disappear in the clouds, multiplied by five and a half, gives the exact height in feet of the "ceiling."

At night, a different method is employed. A powerful searchlight beam is projected at an angle of forty-five degrees and the point directly under where the beam strikes the clouds is determined. As the distance from the searchlight to this spot can be measured and used as the base of a right angle triangle, the upright leg of such a triangle can be computed, and its length gives the height of the clouds above the earth.

Plant "Pills" Grow Bumper Crops

(Continued from page 157)

the greater number of the destructive insects.

Careful calculations, based on actual experiments with these tanks, indicate that in two or three seasons the vegetable grower would repay himself, from the extra production, for the original outlay for tankage.

It has been determined that the best division of the shallow tanks is in small sections measuring twenty by ten feet. This facilitates the planting and gathering of crops, and the maintenance of the water level. Such small sections also would enable the farmer to control more closely the area devoted to each vegetable, depending on market and demand. Cost of the "pills" for large-area fertilization will run about one-half that of the best commercial soil fertilizers, but, with the water tank method, the variability of soils and their differing demands for "renewal" are eliminated.

CLIMATE, absence or presence of humidity, richness or poverty of soil—none of these formerly vital factors in agriculture, seems to affect results so far achieved by the Gericke discovery. Though it will not make a new plant grow in a climate to which it is not adapted, it will increase size, production, and rapidity of growth of all commercial crops in their own proper zones.

Thus, Dr. Gericke and his students produced, in controlled areas, conditions of heat and aridity similar to those of the desert sections of Arizona, New Mexico, and southeastern California. On these miniature deserts, they set up tanks, in which were planted radishes, turnips, beets, lettuce, spinach, chard, tomatoes, egg plants, and other food crops. It was found that, compared with 3,000 tomato plants—a heavy cropping from one acre of soil—more than 20,000 plants of equal size and strength could be produced in one acre of tanks, with twenty-five to sixty percent greater productivity.

Dr. Gericke is convinced that the real importance of the new discovery lies in the application of the tank principle of food production to the arid regions of the world.

"It has been proved," he told me, "that the sands of the desert are fertile, if water can be placed on them in sufficient quantity. But there are millions of such acres to which water cannot now be, and probably never will be, supplied in amounts sufficient for adequate irrigation. Yet a few gallons of water, thinly covering the bottom of a comparatively cheap tank, can be made to produce food in abundance, in the midst of the most barren desert. Any small spring will supply this water; it can be hauled in at a profit, or it can be caught in those areas where even a slight rainfall comes every winter. Anyone can build the tanks, and in the equable climate of the desert, from the latitude of Arizona southward, two crops a year, or at worst three crops every two years, can be produced."

TO COVER the bottom of a tank twenty by ten feet in size, containing 171 tomato plants, for example, requires 100 cubic feet of water—roughly 750 gallons—with the addition of about half as much more during the growing season to make up for evaporation and absorption. If to maintain a six-inch depth, the total of water is placed at 1,200 gallons, an excessive amount, a considerable quantity will remain for the next planting. This quantity of water would not adequately irrigate an area of land one half the size of this tank for one season. Yet an equal area of land, even if thoroughly irrigated, would produce at its maximum, only about one-fifth of the food plants that can be grown in the tank. Each of the earth-grown plants, too, would deliver only about sixty per cent of the production of each of the tank plants.

"There are few sec- (Continued on page 161)

Plant "Pills" Grow Bumper Crops

Continued from page 150

tions of the American desert on which there is no annual rainfall," said Dr. Gericke, "and almost none on which artesian wells cannot be brought into flowing at comparatively shallow depths. One rainfall properly caught and conserved, will supply enough water for a number of these tanks for a year. The output of one small well, insufficient to irrigate adequately one acre of soil, would provide an abundance of water for ten acres of tanks. The cost of building the concrete tank is about one-tenth of that necessary to produce water enough for soil irrigation and to install pumps, reservoirs, and canals for its conservation and delivery to the fields. The tank is independent of gravity or pumps, and water enough to supply many such tanks can be obtained from almost any spring, well, or natural 'tank' on the desert."

IN HIS vision of the future, the plant physiologist foresees every desert spring surrounded with flat, shallow tanks, each containing a few inches of water, and each filled with food producing plants in numbers sufficient to feed large populations. He declares that the tank system will eventually replace the "furrowed field" as a source of the food for large centers of population. With it, for instance, the roof of a skyscraper could be turned profitably into a vegetable or flower garden. The man with a city lot could add materially to the family income by the use of only a small part of his land.

"There is now open to the man living on the most remote farm, in the most barren land in the world, the means of providing himself and his community at low cost, with all the vegetable foodstuffs the climate will permit," continued Dr. Gericke. "An area less than one-fourth that which, in my boyhood days, supplied the 'garden truck' for the family, will produce foodstuffs of variety, quality, quantity and value never dreamed of by the home gardener. Incidentally, the labor required will be only a small fraction of that needed for proper tilling of the soil. This, it seems to me, is the greatest value of the five years of experiments we have been conducting—that millions may be fed from water, on soils that hitherto have produced nothing but an occasional clump of cacti, or a few fig trees."

Light Exerts Pressure, Experiments Indicate

DR. HERBERT J. BRENNEN, physicist of Northwestern University, a few weeks ago revived the old theory of Sir Isaac Newton, the great seventeenth century English scientist, that light consists of corpuscles, or minute particles, by declaring that light is composed of electrons. This would mean that sunshine and the electrons given off from a hot filament in an electric lamp are, in the last analysis, the same thing—atomic matter.

Dr. Brennen's theory seems to be supported by the fact, discovered by Professor E. F. Nichols, of Yale University, and Dr. G. F. Hull, of Dartmouth, that light exerts a certain pressure upon a body which it strikes, in the same way as a jet of water trained, for example, upon a wall. This pressure is extremely slight, but the two scientists actually succeeded in measuring it. They found that sunlight strikes the earth—or rather that half of the globe which it illuminates at one time—with a force of 160 tons. Later experiments have shown that a ray of sunlight has mass or inertia. According to Dr. Albert Einstein a beam of light is deflected by the pull of gravity exactly like a water jet. The truth of that theory was proved in the sun eclipse of 1919. Professor Einstein, however, does not give the weight of light as the cause of this phenomenon.

The Bulldog of the Insect World

(Continued from page 51)

first frost, so that they never see their offspring.

When the baby wasp breaks from its cocoon in the ground, it immediately digs its way to the surface. For several weeks it lives on sweetened liquids, such as the nectar of flowers, honey dew, or the juice of fruits, lapping its food with a short rough surfaced underlip, much as a cat uses its tongue. During this period, the wasps mate. In July the females start digging their underground nests.

In years when the noisy "seventeen year locusts," or cicadas, are plentiful, they are often used by the wasps in place of the caterpillars. If these insects, far heavier than their captors, are found at any distance from the burrows, they are carried to the spot by a series of curious maneuvers. The wasp drags the body of the paralyzed cicada high into a tree, grasps it firmly, and launches into space. Its tiny wings become a blur as it tries to carry its impossible burden. Wasp and cicada fall to the ground in a long glide that carries them nearer the goal. Then the wasp tugs its prey into the branches of another tree and takes off again. Often three or four glides are required to reach the burrow.

BUT by far the most spectacular battle occurs when the wasp attacks the ugly fur-covered tarantula, which sometimes grows to the size of a baby's hand and lives as long as a horse. Ordinarily this dreaded insect stalks about near its nest like a master surveying his domain. But the hum of tiny wasp wings, heralding the approach of the "tarantula hawk," throws it into a panic. It runs this way and that, searching frantically for shelter. As the wasp circles closer, the great spider alternately scurries away in terror and rears itself to fight. The wasp weaves in and out with lightning-like dashes that confuse its adversary. The spider strikes out again and again, missing each time. At last it tires, leaves an opening, and the wasp, one-sixth its size, dashes in. One plunge of its paralyzing stinger and the battle is over.

However, it is not in such deadly gladiatorial contests, but in its steady attack upon cutworms and garden pests, that the wasp proves a friend to farmers. Experiments may soon be made in breeding quantities of these insect allies within laboratory walls. If such tests succeed, squadrons of the blue and orange battlers will be sent forth to join the insect army now fighting for man.

Gems Made to Order in Chemist's Laboratory

A FRENCH chemist, Louis Nolet, is reported to have discovered a new process for the synthetic manufacture of precious and semi-precious stones, including emeralds, rubies, sapphires, opals, amethysts, and topazes, as well as marble, ebony, and jade.

Such a discovery may make it unnecessary for men to go to the ends of the earth for gems. A synthetic stone is not an imitation. It has the same chemical composition as the natural jewel, but is made by man instead of by Nature. An imitation has much the same appearance as the real gem, but possesses a different composition. A reconstructed stone is made of small pieces fused together. This process has proved most successful with rubies. Pearls are also sometimes made in this manner.

Of the 1,200 kinds of minerals known to science, only about 100 are classed as precious or semiprecious stones. Most of these, experimenters predict, may be produced in the chemist's laboratory.

Feeding 13,000,000 Radio Sets

(Continued from page 41)

Mr. Aylesworth smiled. "You mean when a speaker in the Democratic national convention was shut off in the midst of a denunciation of the Republican agricultural platform? That was an accident, and a funny one. Some prominent Democratic publishers called me on the telephone from Kansas City to protest. I started an immediate investigation, although I knew it had not been done deliberately.

"I discovered that only the Eastern stations had been cut off. The interruption must have occurred somewhere on the telephone wires connecting these stations. The telephone company engineers traced the break. They found that three small boys near Pittsburgh had climbed a pole and cut out a length of wire to fix a cage for a pet rooster!"

THAT was an accident, as was the breaking down of one of the telephone circuits one night when Secretary Hoover was speaking. But Mr. Aylesworth told me of deliberate attempts to prevent certain messages from getting on the air.

"On the night of Senator Curtis' acceptance speech," he said, "someone telephoned our control room. The man who took down the receiver heard an excited voice exclaim: 'Stop the program! There's an SOS on the air. WEAF is the only station running! Cut off at once!'

"The young man in charge was about to throw the switch, when the chief engineer intervened. He quickly tuned in on other stations. All were running. If the ruse had succeeded, Senator Curtis would have been cut off in the middle of his speech."

Sometimes, when a piece of news of unusual interest or importance is reported, the broadcasting organization itself cuts in on a program. For example, last New Year's Day a California player in the East-West championship football game made a sensational run—in the wrong direction. That was unusual news. A program was interrupted long enough for a brief description of the freak event to be broadcast. In such a case, the sponsor, whose time on the air has been curtailed, is refunded a proportionate part of the sum he paid.

"What happens in the studio when you get an unexpected piece of news or have to go off the air for an SOS?" I asked. "Doesn't it throw your performers out of their stride?"

"Not at all," smiled Mr. Aylesworth. "They never know it. They keep on with their programs just the same. But their microphones are disconnected until the SOS or whatever the interruption may be is out of the way.

IN BROADCASTING news events from points outside the studio, Mr. Aylesworth told me, "nemo men" play an important role. They set up the microphones at the scene of action, at football fields, ballrooms, banquet halls, theaters, or other places where special programs are broadcast. In New York City alone, there are nearly three dozen of these "nemo" points from which speeches, music, and entertainment are broadcast regularly. All lines from the "nemo" points lead to the control board of the main studio.

When features are sent out from theaters or concert halls, the "nemo" operator must attend several performances or rehearsals in advance to make notes and prepare cues for the actual broadcasting, as well as to plan the arrangement of the microphones. As many as sixteen "mikes" may be employed in a typical theater pick-up.

One hour before a "nemo" program is scheduled to go on the air, the circuits are tested to make sure everything is in order. Fifteen minutes before the opening selection, the lines are again tested. Five minutes before the deadline, the (Continued on page 164)

Feeding 13,000,000 Radio Sets

(Continued from page 153)

"nemo" operator is given his cue to stand by.

Besides the regular "nemo" points with more or less permanent equipment, there are special points for special features. When Lindbergh returned from France for example, radio reporters were stationed before microphones at the Washington Navy Yard, on the steps of the U. S. Treasury, on top of the Washington Monument, in the cupola of the Capitol, and at the flying field in Washington, so that every step of his progress could be reported.

In this way chain broadcasting covers the great news events whenever they can be anticipated.

A striking example of how a national hook-up can cover an important event, allowing speakers in all parts of the country to participate, was the opening of the Cascade Tunnel of the Great Northern Railroad, last January. Ralph Budd, president of the company, spoke from the tunnel's mouth, in the state of Washington. Then a member of the Interstate Commerce Commission spoke from Washington, D. C. General W. W. Atterbury, president of the Pennsylvania Railroad, spoke from Philadelphia, Madame Schumann Heink sang from San Francisco; an orchestra played in New York, and Herbert Hoover then Secretary of Commerce, closed the program with an address from Washington, D. C. There were twelve switches across the continent to make up a single program lasting one hour.

BROADCASTING news features is but one phase of the "unsponsored" programs paid for by the broadcasting company itself instead of by an advertiser.

"The main purpose of broadcasting," Mr. Aylesworth said, "is not to make money. It is to give the public each increasingly better programs that people will continue to buy and use radio sets and tubes. And that works to the advantage not only of the manufacturing companies whose money is invested in the National Broadcasting Company, but to all makers of radio equipment, and the general public as well.

"I believe the time will never come when all radio programs will be sponsored by advertisers. There are certain public services that broadcasters must render if they are to continue in business. Sending out religious services is an example. We make no charge for broadcasting those. I believe the number of people who listen to Dr. Cadman, Dr. Fosdick, Dr. Poling, and Rabbi Wise is greater than the total church attendance in the United States.

"THEN there are addresses by public officials. When the President of the United States speaks, we feel it our duty to give everybody a chance to hear him. The same is true for lesser officials on special occasions. Again, there is the noonday agricultural bulletin service prepared by the experts of the U. S. Department of Agriculture. It produces no revenue for us, but it reaches a great public which has signified its interest by writing us tens of thousands of letters. We also broadcast without charge the important sporting events, and many kinds of musical programs. We have one feature, 'Cheerio,' a brief inspirational talk every morning at half past eight which thousands of radio listeners regard as the most valuable thing they hear. We know that because of the letters we get—more than 100,000 a month. When Cheerio last spring suggested that perhaps people were getting tired of hearing him, we got 56,000 letters in one day begging us not to let him stop."

For these unsponsored entertainment and educational programs, supplied by the broadcasting company; each associate station is charged forty-five dollars an hour. They are at liberty to use as

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Feeding 13,000,000 Radio Sets

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many or as few of the unsponsored hours as they desire.

I wanted to know how many people are reached by chain broadcasting.

"We can make a pretty close calculation," Mr. Aylesworth answered. "Manufacturers tell me that about 13,000,000 sets are now in use and that this year's sale of 5,000,000 or more, after allowing for replacements, will increase the number being used to more than 15,000,000. Allowing only a fraction over three persons to each set, we have a possible radio audience of 50,000,000 in the United States.

"INTERNATIONAL broadcasting is coming," said Mr. Aylesworth. "I have just returned from Europe, where I looked into that possibility. Though few European stations are equipped yet to render effective service, I found them all interested in our musical programs and in our public addresses. Even on the Continent, there is a rapidly growing audience which understands English."

One curious thing about English radio sets, Mr. Aylesworth related, is that headphones are used with most of them. There are few loudspeakers. In the British Isles, radio is almost universally called "wireless." When it is called "radio" the word is pronounced with a short "a" as if it were spelled "raddio." During the last presidential campaign, many people made fun of Governor Smith for speaking of the "raddio." Apparently, he had authority for the pronunciation.

Already international broadcasts are meeting with considerable success, I was told. Features from New York are rebroadcast by short waves from stations KDKA, in Pittsburgh, Pa., and WGY, in Schenectady, N. Y. As a result, South America is getting many of our programs.

"In these experiments," said Mr. Aylesworth, "we have learned some surprising things. For instance, in the north-and-south direction, the short wave system seems to work pretty well. Eastward and westward, however, the results are not so good. The British Broadcasting Company made great preparations to pick up President Hoover's inaugural address, but all they got clearly was the administration of the oath of office by Chief Justice Taft.

"ANOTHER strange thing is that the power of a station sometimes doesn't seem to have much to do with its range. Take our principal station, WEAF, as an illustration. It is located on Long Island twenty-two miles from New York. Its power is fifty kilowatts, but its signals arrive in Manhattan with an energy of only five kilowatts and some parts of the city cannot pick them up at all. Station WOR, in Newark, N. J., has only five kilowatts of power, but reaches some parts of New York better than WEAF does. Radio engineers can only partly explain such things. They are mysteries that will have to be solved before international radio becomes entirely dependable.

"And new developments in broadcasting?" I asked in parting.

"The presentation of drama over the radio is one thing. Experiments in that direction have met with wide approval. Great plays can be rearranged to carry their appeal through the ear alone. We are also looking forward to sound movies, broadcast from radio stations and received in the home. I doubt whether we will have successful visual presentation by television of events as they occur. Engineers tell me that there are almost insurmountable technical difficulties in the way of such transmission. But we expect, some day, to present the face, and perhaps the figure, of the speaker before the microphone, though not life-size."

Here Are Correct Answers to Questions on Page 70

1. The light sensitive material on the celluloid film consists of a mixture of gelatin and silver bromide. In some way not yet fully understood, the light falling on the silver bromide causes a molecular change in its structure which cannot be detected by ordinary means but the effect of which shows up in the development of the plate. The silver bromide which has been exposed to light is acted on by the developing agent and reduced to metallic silver in such a finely divided state that it appears black. The silver bromide not exposed to the light is not affected by the developer and subsequently is dissolved away by the hyposulphite of soda solution called the fixing bath.

2. The difference between a fast lens and a slow lens is not in the material of which the lens is made. A fast lens is one which will focus a sharp picture with a relatively large opening, so that a greater amount of light is allowed to strike the sensitive plate. With a fast lens, therefore, the exposure is shorter, because the silver bromide is more rapidly affected by the stronger light coming through the larger opening.

3. Daguerre and Niepce made the first photograph in 1839.

4. The focal length of a lens determines the size of the image which will be produced on the plate. The shorter the focal length the smaller the image on the plate if the distance from the object photographed to the lens remains constant. The proper focal length of a lens, therefore, is such that the view embraced within an angle of forty-five to fifty degrees will be reproduced on a plate of the size you wish to use. This means, roughly, a lens of eight and one quarter inch focal length for a five by seven plate or of six-inch for a four by five plate, and so on. If a longer focal length lens is used the angle of view embraced by the camera will be smaller than forty-five or fifty degrees.

5. Pictures of sporting events are usually taken with cameras equipped with focal plain shutters. Such a shutter consists of a curtain with a thin horizontal slot in it which travels from top to bottom, in front of and close to the plate in the camera. The entire plate therefore, is not exposed at exactly the same moment, and, as the image is projected on the plate upside down, the wheels of a racing car, for instance, are exposed on the plate before the upper part of the body. In the meantime the car has moved slightly, so that the wheels are photographed when the car is in one position, and the upper part of the body when it is in another.

6. Special lenses are needed to take colored movies only in the sense that a very fast lens is necessary. Such a lens will work equally well for ordinary photographs without color. The high-speed lens is necessary because in front of the lens must be placed colored filters which cut down the effect of the light to such an extent that much more light is needed.

7. The maximum size of a sharply defined enlargement depends entirely on the sharpness of details in the original picture. If the original picture is very sharp there is no practical limit to the size of the enlargement which can be made, for the larger the enlargement the farther away the observer will naturally stand when looking at it, so that the detail will apparently remain as in the original picture.

8. Besides the fact that an anastigmat lens is faster than a cheaper lens, it gives much sharper definitions, (Continued on page 157)

Here Are Correct Answers to Questions on Page 70

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particularly near the edges of the picture. The ordinary cheap rapid rectilinear lens focuses sharply only at the center of the picture, whereas the anastigmat lens covers the entire plate with great sharpness.

9. Stereoscopic pictures are taken in a camera fitted with two lenses separated at the same distance as are the human eyes. Consequently when you look at a stereoscopic picture through the proper lenses the view appears exactly as you would have seen it if you had stood in front of the camera when the exposure was made. The eyes automatically superimpose one view over each other, so that near and far objects bear the same relation to each other in the picture as in the actual scene.

10. The speed of a lens, or the rapidity with which it will properly expose for any given picture, depends on the opening through the lens. The "f" stands for focus. An f/8 lens, for instance, is one to which the largest stop, or opening in the diaphragm, is one-eighth of the focal length. An f/8 lens, for instance, of eight-inch focal length, could use as its largest stop a diaphragm with an opening one inch in diameter. An f/6.3 lens of the same focal length could use a maximum stop or diaphragm opening of 1.269 inches.

A New Slant on House Painting

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be painted for the same reason, and so will the top and bottom edges of the doors. Going to varnish the floors?"

"I don't know. Is that the thing to do?"

"Yes, if they're wood. I go over an oak floor twice with filler to fill the pores, and then give it three coats of the best varnish I can get. Wax it, and you'll have a floor to be proud of. Your inside walls are to be plaster, I take it, and I recommend flat paint, maybe stippled."

"Flat paint? What's that? Doesn't all paint lie flat?"

"That's not the kind of flat I mean," Martin smiled. "Paint with no shine in what I'm talking about. You see, when you make paint with linseed oil it dries with a gloss, and you can't get anything better to use outdoors, because it turns the weather. But people don't like shiny walls inside; they prefer a dull finish—flat. That kind of paint is made with turpe instead of linseed, or some other kind of oil that doesn't gloss. The trim is different. That can be glossy, glossier than paint even, so it's generally enameled. Enameling used to be a fussy job. But there are new enamels out that only take four hours to dry and are so easy to put on that anyone can do it."

"Is that the stuff called lacquer?"

"No, that's something else. Enamel is made with linseed oil, but lacquer has the same stuff in it as celluloid. When lacquer came out everybody began to use it because it dried so fast; you could lacquer a chair and use it in half an hour. But then enamel was made to dry almost as fast, and now lacquer is used mostly for furniture and small things, and enamel for trim and big surfaces. Lacquer is used on floors, too, because it's so hard."

To Bob, the advice of his painter friend was a revelation, for where he had thought of paint only for its appearance, he now recognized it as a powerful agent of preservation against rot and rust. The economy of a paint job, he saw, was not in its first cost, but in the length of time it would last, and so he counted himself fortunate in having the painting of his new house in the hands of so competent a man as Jim Martin.

Fish Kept Fresh 1,500 Miles from Sea

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it back again. The result is a compact refrigerating system controlled by a thermostat that automatically holds the interior of the car at any desired temperature, whether it is twenty degrees for frozen fish or forty degrees for cantaloupe.

In a recent experiment a shipment of ten tons of frozen fish was sent from Groton, Conn., to Fort Worth, Texas, where it arrived after eleven days, with the temperature of the contents at fourteen degrees—four degrees colder than when they started. After this experiment, the frozen fish firm that made the shipment ordered an entire fleet of the new refrigerator cars.

Supplementing these rail carriers are motor trucks that provide winter cold for meat and fish. Striking in appearance, they are painted shiny aluminum or pure white to reflect away outside heat. One type keeps its interior cold with blocks of "dry ice," an artificial snow at 109 degrees F. below zero. Lowered through hatches in the top for transporting ice cream, they can maintain a temperature of six degrees F. Fifteen degrees is cold enough for frozen fish. Other trucks use mechanical refrigerating plants with compressors run from the drive shaft, or silica gel cooling systems like that of the new-type freight car. One novel system places cans of frozen brine—really "salt water ice"—within the compartment of a motor truck or motorcycle with delivery compartment, and maintains the chamber at temperatures as low as two degrees.

COLD storage trucks such as these operate over considerable distances, as between Chicago and Milwaukee and between Exmore, Va., and New York City—the latter a run of fifteen hours or less for a fast truck. They carry all manner of perishable goods, from butter to frozen fruit. One unusually large truck used by a Brooklyn, N. Y., firm of packers transports eight tons of meat chilled to forty-five degrees or lower.

Refrigerator cabinets for retail stores complete the chain of low temperature handling from factory to buyer. These convenient little metal boxes, which stand in the corner of a grocery store, are kept cold with dry ice. They keep packages of products such as frozen fish ready for the customer. Here, then, is a sort of sub-freezing "underground railway" that keeps food fresh from the factory to the home.

Storage yards and depots along this imaginary railroad are the cold storage warehouses, the great food reservoirs whose combined chilling power in the United States is equivalent to the melting of about a million tons of ice a day. The average warehouse keeps almost half its rooms at less than zero, and none of them at more than thirty-four degrees. And not a single cake of ice will you find anywhere in the building. Instead, a maze of pumps and compressors forces chilling ammonia through the pipes and maintains the rooms at a dry, searing cold.

STRANGE things are kept in these cold storage rooms—nuts, furs, ink, plant seeds. Even a consignment of rattlesnakes once went into cold storage in a Southern state. Imagining winter had come they hibernated and remained in their winter slumber until they were sold, thus disposing of what might have been an embarrassing storage problem.

The boon of cold storage is that it enables surplus food products obtained in times of plenty to be held over until a time when the supply is scarce. The result is that prices are stabilized and a plentiful supply at all times is assured. And as for the familiar question, Are things kept in cold storage as wholesome as fresh foods? the Food Research Laboratory of the Bureau

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Fish Kept Fresh 1,500 Miles from Sea

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of Chemistry at Washington, D. C., has gone to some pains to answer it.

It finds that, with today's modern facilities, poultry, meat, fish, butter, and eggs can be stored from nine to twelve months without even appreciable loss in flavor—and much longer without loss in food value or wholesomeness.

As a matter of fact, this is far in excess of the actual time such articles are stored. The average for most of the principal food products is less than six months. To give a few typical figures, eggs are usually kept slightly less than six months, beef, about two and a half months poultry, two and a half months; mutton, four and a half, fish, six and a half

The chemists also found that a chicken is more likely to spoil after only a couple of days in the housewife's icebox than after fourteen days in the well-chilled box of the wholesaler or after eight months in the freezer of the cold storage warehouse where the temperature is about ten degrees F. Eggs six months in cold storage cannot be told from fresh ones; the test has been tried many times.

Moreover, only foods of the finest quality are sent to the cold storage rooms, the others, which do not keep as well, must be sold at once. Thus it may happen that "cold storage" food may often be of better quality than "fresh" food, despite the traditional prejudice against it

FROM cold-storage handling on a large scale experts have learned many facts that can be applied to good advantage in a housewife's icebox. Lemon and eggs, as most housewives know, cannot be kept in the same icebox; the eggs come out with a pronounced lemon taste So marked is this property that cold storage men do not even keep them in the same building. The same characteristic is true of other citrous fruits, though lemons are the worst offenders. Along with oranges and canteloupes, they should be kept as near as possible to the top of the ice box, where the air circulation is best and odors are less likely to be carried downward to the lower shelves. Meat butter, poultry, milk, and drinking water belong in the coldest part of the box, right next to the ice section. Bananas and butter don't get along well together in the household refrigerator, and fish are a familiar source of trouble—though a fish carefully cleaned and washed is almost odorless. Fish are seldom carried in general cold storage, as they form a separate branch of the business.

One mistake made by inexperienced housekeepers is the pacing of a sheet of newspaper around the ice cake to conserve it. True, it keeps the cake from melting—and by the same token it destroys the efficiency of the ice box which is kept cool solely by the *melting* of ice. If wrapping must be done, it might be well to insulate the whole icebox against the heat of outside air Modern mechanical or electrical household refrigerators are already insulated

Nine-Day Mail to Chile

IT TAKES a letter nine days, now to travel from New York to Chile. The new air mail service, just opened, clips ten days or more from steamship time and opens a new era of speedy communication between the United States and South America.

The long-awaited service is an extension of the American air line that already stretched as far south as Mollendo, Peru. Now reaching to Santiago, Chile, it gives impetus to an aerial network that is speedily linking all of South America with an airway system as modern as that of the United States and in many ways more ambitious.

First Scientific Census

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tinguishable from thousands of others like it by tell-tale holes made by punching machines. These holes represent a mechanical translation of the information written on the census card. Thus they identify John Smith, tell his occupation, age, and so on.

About 1,000 girls transfer the information from the forms to the cards by means of hand-operated punching devices. But when cards are being prepared for a certain locality, New York State, for example, the robots are brought into play. Part of the punching is done by the automatic gang puncher which can be adjusted to handle cards in any desired grouping such as occupation, nationality, or age.

From the punching machines, the cards go to other devices which sort them according to the information desired. This operation requires from fourteen to sixteen runs for each set of cards. For instance the nationality of the citizens of the State of New York is to be determined. The New York State cards are run through the assorting machines. Fast moving rollers carry the cards over the robot's swift mechanical fingers. As these fingers reach the holes designating nationality, the cards drop into various containers—the German-born in one, the British-born in another, and so on.

OR SUPPOSE that the Bureau wants to find out how many people in New York State are white. The cards are rerun through the assorters, and the machines separate the various races according to the punched holes.

To sort the cards according to occupations of professions, the cards again are rerun and reassorted. As many as twelve different groupings can be made by one of the new machines.

The assorters, however, do no counting. That part of the job is left for the automatic tabulators, which are operated electrically. Tiny wire brushes form electrical contacts through the holes in the cards and electrically record the totals to be ascertained.

For example, if the persons in various occupations are to be counted, the cards are taken from the assorters and placed in the tabulators. Each of these is able to count as many as ten different occupations at one time. As the cards pass through, the wire brushes, adjusted for that particular count, reach for them. Electrical contacts are made at the holes, and the recording device, similar to that of an adding machine, registers the number. At the end of the run a button is pushed and the total is printed on a slip of paper—not only the total of persons in one occupation, but the totals for all of the occupations at the same time.

PRIMARILY the census was started to learn the population of the country. In 1790 federal marshals were assigned the task. They were allowed thirteen months for the enumeration and returned a total population of 3,929,214. Since then, the nations of the world have been developing methods for speedy enumeration of their people.

Some countries, however, have been backward. Only two years ago, Turkey decided to take its first census. Modern methods were discarded. The Turks imprisoned the entire population in their houses on the day of the census; no one was permitted on the streets except armed guards and census takers; business and industry came to a halt, no trains or street cars were run. In Constantinople it was not until the count was complete at 10:15 P.M. that the people were released from their homes by the signal guns.

Fortunately such a drastic method is not necessary in the United States. The population of this country has been increasing at the rate of about 1,400,000 persons a year, or one person every twenty-six seconds. The major part of the increase is made up of the excess of births over deaths, which amounts to 1,150,000 annually. The

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First Scientific Census

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other part results from the increase in immigration over emigration, which adds 240,000 persons every year

The most conservative estimates place the 1930 population at twice what it was in 1890, only forty years ago, and thirty times as great as it was at the time of the first census.

History records no other instance of a population increasing so rapidly. Moreover, there has been no other nation in which the increase in population has been accompanied by such improvement in the wellbeing of the people.

In commenting on this state of affairs, William M. Steuart, director of the Bureau of the Census, said:

"As a statistician, I believe that this advancement has been due in no small degree to the definite knowledge we have of our production, our resources, our facilities for transportation, and our population as expressed in the census statistics."

IN 1790, the 4,000,000 persons who lived in the United States occupied a territory of 868,000 square miles, or 4.5 persons for every mile. The present continental area is 2,974,000 square miles, and it is estimated the average population per square mile in 1930 will be more than forty, nearly a thousand percent increase.

In 1790, only six cities in the United States had as many as 8,000 inhabitants. The population of these cities formed a little more than three percent of the total population of the country. In 1920, there were 924 such cities and their population was forty-four percent of the total. Including the population of smaller cities down to those with 2,500 inhabitants, the urban population of the United States in 1920 formed slightly more than one half of the total, and the rural less than one half, while the strictly farm population was less than thirty percent.

It appears, therefore, that this is becoming more and more a nation of cities. But there are certain strong factors operating against this tendency. One of the most potent is the automobile, which carries the city worker to a home in the suburbs.

WHEN the United States started the first census, only the names of heads of families and the number of persons in each family were recorded. For example, aged and yellowing books at the Census Bureau show the family of John Hancock as comprising two white males over sixteen years of age, three white females, and seven other free persons not white, who were presumably negro servants.

Starting with the census of 1850, the name of each individual in the family was recorded. The books for 1860 show the family of Abraham Lincoln enumerated at Springfield, Ill., as consisting of Lincoln, his wife Mary, his three sons, Robert T., Willie W., and Thomas, a servant, and a boy of fourteen named Philip Dinkell. Each individual was asked to give the value of his real and personal property. Lincoln returned $12,000 for his personal property and $5,000 for his real estate.

When the system of individual enumeration was adopted in 1850, a number of new classifications were added, including illiteracy, school attendance, occupation, age, and place of birth. In 1870 the question of nativity of parents was added.

In later censuses, the foreign born have been classified according to country of birth, year of immigration to the United States, whether naturalized or alien, and their ability to speak the English language.

The present questions of census takers cover an even wider field, including marital conditions, religion, occupation, and the like. They will give a microscopic view revealing priceless information which eventually will benefit most of the citizens of the United States.

The Zeppelin Grows Up

(Continued from page 35)

of Zeppelin's commercial ships for military service. Several military Zeppelins were already in use by the German army and navy, and more were ordered. Not everyone knows that during the four years of fighting, the four great Zeppelin plants then in operation built eighty-eight of the air leviathans. More than 1,000 men labored at one factory, at Staaken, Germany, to turn out the giant night bombers that raided London and Paris in 1917 and 1918. But casualties were heavy among them, and some of the lessons learned in the war played an important part in the improvement of modern airships.

ONE day four German Zeppelins, returning from a military mission, were caught in a storm at 18,000 feet altitude and swept over Allied lines, where all were shot or forced down. The engines designed for sea-level conditions, had failed in the rare air of high altitudes. Out of this experience came the present high-altitude airship motor, over-dimensioned and with surplus compression, which develops maximum power at about 10,000 feet.

One of Count Zeppelin's inventions during the war was the Zeppelin observation car—a sort of upside-down periscope. While the airship lay hidden from the enemy above a bank of clouds, an observer in a tiny inclosed car would be lowered to the end of a cable five-eighths of a mile long. Just below the clouds, he could direct the operation of the ship and even signal for bomb releases by telephone—praying meanwhile, no doubt, that the bomb would not hit him.

While the Zeppelin plants were turning out military airships, the inventor found time to experiment with a new type of duralumin dirigible designed especially for aerial photography. He was successful, and construction of a number of these machines was interrupted only by the Armistice.

In the four years of the war the speed of Zeppelins had increased from forty-seven to eighty-eight miles an hour. To carry useful loads of forty tons, their hydrogen capacity had been raised from 700,000 to more than 2,000,000 cubic feet. Commercial ships were built after the war embodying these improvements. The Zeppelin was growing up.

COUNT ZEPPELIN died in May 1917 at seventy-eight, still dreaming of peace-time Zeppelins for world wide transportation. Had he lived a little longer he would have seen a definite sign of the airship's future role in long distance travel. British troops were besieging German colonials in German East Africa. The Zeppelin *L-59* was sent to carry ammunition and medicine to the beleaguered defenders. Picking up nine tons of machine gun ammunition at Jambol, in southern Bulgaria, it set sail for Africa.

Just as the ship was crossing the Sahara desert the German Intelligence Office intercepted a British radiogram that the Germans had surrendered. The *L-59* had just passed through a storm and had taken in her wireless antenna. It was not until she was west of Khartum that she listened in and picked up Headquarters' frantic message not to land. The *L-59* turned without stopping and, flying high over Asia Minor and the Black Sea, reached Jambol after having traveled, in four days, 4,225 miles non-stop. It was a world's record for any kind of aircraft, and at that the *L-59* had enough fuel left in her tanks for two or three days more in the air.

Two years later, the British airship *R-34*—said to have been patterned after a German Zeppelin captured in the war—fulfilled Count Zeppelin's vision of trans-ocean airships by making the first round trip across the Atlantic.

In 1924 the *Los Angeles*, America's share of German reparations, *Continued on page 164*

The Zeppelin Grows Up

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crossed the Atlantic from Friedrichshafen and landed at Lakehurst, N. J., with enough fuel in her tanks to proceed to Chicago. This ship marked the permanent departure in hull shape from the older "lead pencil" design, pointed at both ends, to a shape more like that of an egg. The result was greater strength

The *Los Angeles*, then, was the last of the Zeppelins. Its 125 predecessors all had been destroyed—some by fire, some by storm, some by hostile incendiary bullets. Yet out of this heap of broken hopes was to rise the newest and in many ways the best of them all.

The *Graf Zeppelin*, named appropriately for Count Zeppelin, was the embodiment of every lesson learned in building its predecessors. When it reached Lakehurst from Friedrichshafen, Germany, this year, it had fuel enough left for at least thirty hours more of flying. It had flown 5,000 miles in ninety-three hours, carrying sixty-one persons and tons of mail and express. One of its outstanding features was the method of maintaining a constant weight. Its "blau gas" fuel, used instead of gasoline, weighed about the same as air and hence did not lighten the ship when it burned. By way of contrast, the *Los Angeles* weighed twenty-two tons less when it arrived here than at the start, requiring the valving off of valuable lifting gas to keep it down to normal level.

WHAT is the Zeppelin's future? A hint is to be found in the great new rigid airships under construction here and abroad. The British *R-100* and *R-101*, are intended primarily for fast mail and passenger service in such distant lands as Argentina, Australia, Canada, Egypt, Norway, India and Spain, where mooring masts and hangars are being built for them. They use hydrogen lifting gas, of which each carries 5,000,000 cubic feet.

The two giant dirigibles for the United States Navy will incorporate perhaps more radical improvements than any of their predecessors. Each will have three backbones, triangular keels running from one end to the other, in the upper half of the envelope. They will be so strong, with bracing rings spaced along the ship's length, that they will require no wires for further rigidity—a construction that permits all parts of the ship to be inspected during flight. Inside the keels will be long corridors, promenade decks, and sleeping quarters.

EIGHT 600-horsepower Maybach motors will each have its own compartment inside the hull, avoiding wind-resistance. The only parts of the ship projecting outside the hull will be control surfaces, propellers, and their supports.

Power will be delivered through solid shafts to propellers mounted on outriggers. The propellers, of novel design, can be rotated from horizontal to vertical. Thus they can lower and raise the craft without waste of gas.

Space for five or more airplanes within the hull is another novel feature of the two new Navy ships. The planes may be launched from the mother dirigible and return to it while it is in flight. Each of the ships, though slightly larger than the new British dirigibles will have about the same lifting power. The helium gas to be used in the American ships has a lifting power slightly below that of hydrogen. Its greater safety is expected to compensate for the difference.

Little does the $2,000,000 hangar at Akron where America's newest airships are taking shape resemble the shed on Lake Constance where Count Zeppelin constructed his first airship. The modern dock is 1,175 feet long and its unobstructed floor space covers eight and a half acres. A ship of 10,000,000 cubic feet could be built in it. Perhaps some day it will be. For the Zeppelin has indeed grown up.

Everyday Wonders in Colloid Chemistry

average colloidal particle, and take a dive into a cupful of jelly set out to cool and harden, he would see remarkable sights. Throughout the bright red ocean in which he would find himself swimming, there would be drifting slowly a number of barrel-like masses of thicker fluid, like giant jelly fish. No sooner would he get used to these companions than he would notice an alarming fact. The great floating bodies are swimming [illegible] and come closer together. Finally they touch like toy balloons pressed [illegible] and our swimmer would find himself pressed into one of the small, many-cornered spaces between the swimming bodies. That is precisely what happens [illegible] on an ultramicroscopic scale, when a cup of jelly turns hard.

In the beginning the warm, liquid solution is a colloidal one. Its particles are tiny globules of the jelly substance mixed with the elements of water. As such a jelly mixture is warmed the globules shrink. What happens, in fact, is that they sweat out some of their contained water into the surrounding solution. If the mixture grows colder instead of warmer the globules swell by absorbing water. The instant that they swell enough to touch one another the jelly stiffens. When they are swollen enough to press tightly against each other the jelly is fully hard.

THIS happens in any kind of jelly, gelatin, agar agar seaweed or an [illegible]. There is a material called pectin—plentiful in apples, in the inner rind of grapefruit, and in some other natural materials—which is especially good at forming these stiffening internal structures. That is why housewives often mix apple juice with other fruit juices to make stiff jellies. The pectin in the apple juice does the stiffening, the other juices supply the flavor.

Glue acts in much the same way; most kinds of glue, indeed, are merely varieties of gelatin. To make any two surfaces stick together, it is not necessary [illegible] to insure that the space between them is filled up. [illegible] open spaces between them. [illegible] stick together [illegible] themselves. Surfaces of [illegible] materials do not do this because they are not flat.

The surface of this very page of paper for example may be seen under a microscope to be a tangled mass of twisted fibers, like fallen tree trunks after a microscopic forest fire. If one sheet of paper is pressed against another, nothing happens, because the surfaces do not really touch. The only contacts are between a few of the higher-lying fibers, as though two landscapes were laid together, touching only by their mountain tops.

THE duty of glue is to fill up these irregularities between the surfaces so that real contact is obtained. Then the natural tendency of most substances to adhere to each other comes into play. One surface sticks to the layer of glue, the glue sticks to the other surface. Intervening roughnesses are filled up by the stratum of colloid glue, the fibers of which deform themselves as necessary to fit into whatever spaces exist. This is why stamps stick to envelopes, why envelopes stay sealed and why all of the other myriad uses of pastes and glues are possibilities.

Ordinary starch paste is another colloid and acts in the same way to stiffen a shirt front or a collar. It fills up spaces between the fibers of the fabric and sticks these fibers together, so that the whole is stiffened, just as the metal fastenings of a bridge or a skyscraper make the whole structure stiff.

Colloids differ among themselves in their abilities to stick to [illegible]

(Continued on page [illegible])

Everyday Wonders in Colloid Chemistry

Continued from page 164

example is the action of soap in removing dirt. Soap makes a colloidal solution whenever it is mixed with water; the dancing particles of soap suds can be plainly seen under an ultramicroscope. These colloidal soap particles are great stickers, especially to the human skin. So anxious are they to stick, in fact, that a tiny film of soap creeps underneath particles of dirt on the skin and literally pries them loose so that the water can wash them away—an example of a great group of forces and actions included under such technical terms as adsorption, surface tension, and interfacial tension.

IN SHAVING, a similar thing happens. The soap not only helps the water to penetrate the hairs and soften them, but a good shaving soap forms a thin, slippery film over the skin so that the razor slips along smoothly and painlessly, without pulling too much on the hairs or catching the skin and making a cut. Oils or waxes used to polish furniture and floors act in much the same way. The colloidal particles fill up rough places between the fibers of the wood so that the surface looks shiny and, what is more important practically, the floor offers fewer microscopic catching places for particles of dust.

Other examples of how waxy, glory and oily colloidal materials stick to things are furnished by face creams, rouges, and other cosmetics. These make adherent layers on the skin, to keep color or powder in place. The forces that hold such layers are among the strongest known to science. Ancient Egyptians, without knowing anything about the science, used the colloidal swelling of wooden wedges to split great stones like those of the obelisks. The colloidal wax which holds in place the red color on the lips of a modern girl clings with an intensity equaling at least 200,000 pounds of pressure to the square inch. That such rouge can ever be got off at all, accidentally or intentionally, is due to the fact that whatever wipes it away removes it bit by bit so that the enormous sticking pressure which the colloidal particles exert is overcome a little at a time.

THESE enormous forces are of importance even to life itself. Sap rises to the tops of tall trees by virtue of colloidal forces. Animal muscles contract in ways apparently not dissimilar. Digestion, nerve action, secretion, and the majority of other activities of the human body are related intimately to these colloidal phenomena. Living matter itself, the mysterious jelly-like substance called protoplasm, which is found in every living cell and which possesses, biologists believe, the essential secret of life, is a colloid. Under the ultramicroscope each living, protoplasmic cell is seen to contain the familiar dancing particles like those in colloidal gold or tobacco smoke or soap-suds.

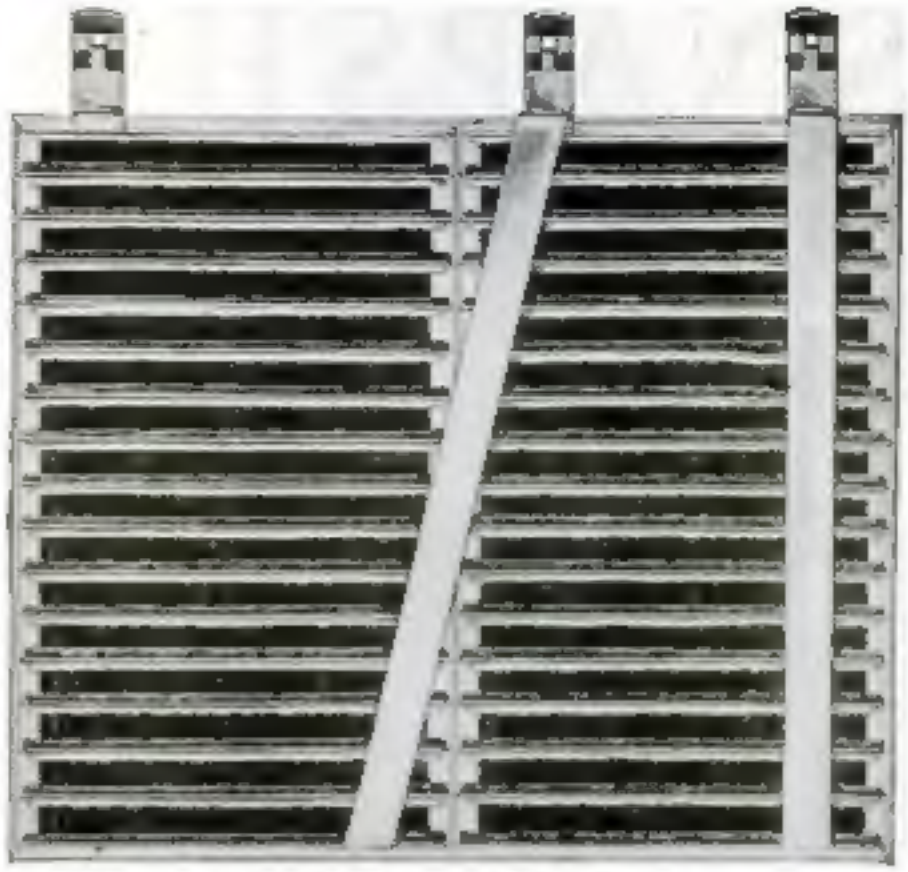
The forces that hold a stamp fast to a letter, or the rouge fast to a flapper's lips, also hold the organs of the human body to their places and activities, even the living cells of the brain to their task of managing the body and producing thought.

Colloid chemistry is far more than a few new ways of handling chemicals. It marks the discovery by science of a whole new world of forces and substances neither so small as those of atoms nor so large as those of ordinary things.

It is the realm, Professor Wolfgang Ostwald has said, of a "neglected dimension," the realm of particles neither very large nor very small.

Cylindrical Cell Construction

Diagram illustrating the construction of a cylindrical cell "B" battery. Two solderings per cell, or 60 in all, and 29 fine wires—89 chances for trouble. Note waste spaces between cells.



Eveready Layerbilt Construction

Diagram illustrating the simplicity of the Eveready Layerbilt construction. Only two broad metal bands and only five soldered connections. No waste spaces. It's all battery. Layerbilt construction is an exclusive Eveready feature. Only Eveready makes Layerbilt Batteries.

HERE IS « THE DIFFERENCE » IN "B" BATTERIES

Here are the facts about "B" batteries assembled of separate, individual cells:

29 delicate, fine wires are necessary to make connections within the battery;

60 solderings are required, making in all 89 places where trouble can come.

These things are true of any such battery, whether the cells are cylindrical, square, hexagonal or any other shape.

Here are the facts about Eveready Layerbilts:

Only two broad connecting bands are needed, each 3/8 inch wide;

Only five solderings are required;

All other connections are made automatically, for the *flat* cells are not independent but *inter*dependent;

This is the LARGE SIZE Eveready Layerbilt No. 486 for heavy duty service—price, $4.25, only 25 cents more than the Eveready cylindrical cell battery of the same size, No. 770. Eveready Layerbilt Medium Size No. 485—price, $2.95, only 20 cents more than the Eveready cylindrical cell "B" Battery No. 772.

PERFECT PROTECTION

Eveready Batteries are used in automatic train control, aircraft beacon receivers, talking motion pictures, short wave transmission, picture transmission, television, where life and property must be protected, and performance safeguarded by the utmost dependability of all apparatus.

The flat construction packs more active materials in the battery case and so you get longer life.

Now you can see why Eveready Layerbilts last so long, are so convenient, reliable, economical. They are the best of all Evereadys, the most popular of all. It will well repay you to insist on these superior batteries. Look for the name "Layerbilt" on the label.

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SNAPSHOTS
don't grow up

When your Boy becomes a Man and your Girl becomes a Woman you'll wish for more reminders of their childhood days

LATER on, when they step out for themselves, snapshots of their early years will become your most precious possession.

Today you are looking ahead. Tomorrow you'll want to look back, to see them as they are now, as they never will be again.

This is the time when your Kodak can be of greatest help, the time to take more snapshots than you have ever taken before.

Children Today—Adults Tomorrow

They change so quickly. You can almost *see* them getting taller, broader, more mature. Perhaps now you're tucking them into bed, buttoning up their clothes, cutting up their meat in little pieces, and keeping them away from open windows. But in only a few years more they'll be telling *you* what to do and looking the part.

When your Boy becomes a Man and your Girl becomes a Woman you'll wish for more reminders of their childhood days. Don't leave this wonderful period to the fickleness of memory. Keep your Kodak next to your hat and coat. Then you won't miss any picture chances because you meant to bring it with you but forgot.

Don't Wait for Sunshine

Then, too, snapshots are fun to take. That is another reason for the extraordinary popularity of Kodaks. They are on sale everywhere and at prices that do their bit toward bringing down the high cost of living. The Brownie, a genuine Eastman camera, sells for as little as $2, and Kodaks as low as $5.

What's more, your dealer can show you Eastman cameras that actually increase your picture-taking opportunities. These are the Modern Kodaks. Many have lenses so fast that you don't have to wait for sunshine. Everyone can take good pictures indoors, outdoors, on cloudy days and brilliant ones, with these marvelous new Kodaks. Ask to see them.

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Thus not a single real excuse has been left you! Remember that your children grow up, but snapshots remain the same as long as you live.

• • •

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General Electric research has made many such practical contributions to the comfort, health, and prosperity of us all, yet most of them owe their origin to the purely scientific curiosity which is the real dynamo of General Electric accomplishment. As a result, the G-E monogram is your assurance of electrical correctness and dependability, whether it appears on the motor that runs your sewing machine or on those that drive great liners out to sea.

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That all vacuum tubes should be replaced after a year of use is the advice of expert radio engineers. When this is done a brand new RCA Radiotron should be put in every socket. New tubes will not do their best in company with old ones.

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UX-222 SCREEN GRID RADIO FREQUENCY AMPLIFIER
UX-171-A POWER AMPLIFIER
UX-112-A POWER AMPLIFIER DETECTOR & AMPLIFIER
UX-226 AMPLIFIER
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WD-11 DETECTOR & AMPLIFIER
UX-28 FULL-WAVE RECTIFIER

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